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MORAG TOLVI

THE WEEKEND EFFECT AND READMISSIONS IN THE HELSINKI AND UUSIMAA HOSPITAL DISTRICT

PATIENT SAFETY IN SECONDARY AND TERTIARY HEALTH CARE

DEPARTMENT OF OTORHINOLARYNGOLOGY — HEAD AND NECK SURGERY
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PATIENT SAFETY IN SECONDARY AND TERTIARY HEALTH CARE

Morag Tolvi

ACADEMIC DISSERTATION

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ABSTRACT

Background: Patients admitted to the hospital during the weekend have been found to have a higher risk of mortality than those admitted during the week. This weekend effect phenomenon has been widely investigated and the reasons for it extensively discussed. The existence of the weekend effect was examined by specialty at the university hospital and six secondary hospitals in the greater Helsinki area during a 14-year period.

The majority of ear, nose and throat (ENT), as well as orthopedic and hand (OHS), day surgery procedures are performed under local or regional anesthesia in Finland. However, this is not true of many other countries. Associations and background factors for overstay, readmission and contacts were investigated at Helsinki University Hospital.

Methods: Data for all inpatients during the years 2000-2013 in the Helsinki and Uusimaa Hospital District were selected retrospectively: for the university hospital, all those treated at some point at the university hospital; for the secondary hospitals, those inpatients only treated in secondary hospitals. Urgency and specialty of care were used to group the weekend effect study population. Associations between variables were analyzed.

Patients undergoing ENT (n=1,011) or OHS (n=542) day surgery from January 1 to March 31, 2015 were collected retrospectively from the hospital's surgery database (GE Healthcare Centricity Opera OR Management Software). The 15 most common procedures were selected for both ENT and OHS day surgery. Data was collected on all-cause overstays, readmissions and contacts during the 30-day follow-up period. For ENT patients, American Society of Anesthesiologists (ASA) class, age, sex, type of procedure and anesthesia comprised the multivariable logistic regression model. For OHS patients, diverse factors related to patient characteristics and anesthesia were scrutinized for their effect on these outcomes using Pearson chi-square test, Fischer's exact test and multivariate logistic regression. For OHS patients, anesthesia charts were also examined and associations between variables were studied using risk profiles.

Results: For the university hospital, data for 1,542,230 inpatients were collected retrospectively for the weekend effect study. Of these, 853,268 were emergency patients. Deaths in hospital or within 30 days of discharge numbered 47,122. In in-hospital mortality, a significant weekend effect was found in 7 of 12 specialties for emergency admissions and 4 of 12 specialties for elective admissions. In 30-day post-discharge mortality, a significant weekend effect was found in 1 of 12 specialties for emergency admissions and 2 of 12 specialties for elective admissions.

For the six secondary hospitals, data for 456,676 inpatients were selected retrospectively for the weekend effect study. Of these, 292,399 were emergency patients. Deaths in hospital or within 30 days of discharge numbered 17,231. In in-hospital mortality, a significant weekend effect was found in 1 of 7 specialties for emergency admissions and 4 of 8 specialties for elective admissions. In 30-day post-discharge mortality, a significant weekend effect was found in 1 of 7 specialties for emergency admissions and 3 of 8 specialties for elective admissions.

The specialties most sensitive to the phenomenon in both the university and the secondary hospitals were surgery, internal medicine, and gynecology and obstetrics. In addition, neurology was also sensitive to the phenomenon in the university hospital.

For ENT patients, sex, age and type of procedure proved to be significant factors on the study outcomes of overstay, readmission and contact. General anesthesia patients had an overstay or readmission 3.2% (n=23) of the time, while local anesthesia patients only 1.4% (n=4) of the time. The majority of study outcomes occurred in tonsil surgery, which was only carried out under general anesthesia.

For OHS patients, statistically significant factors related to outcomes of overstay, readmission or contact were female sex, total amount of fentanyl, use of remifentanil, other pain medication during procedure and administration of antiemetic medication. General anesthesia and plexus block, total amount of oxycodone and postoperative pain medication emerged as borderline significant factors on outcome after day surgery. Combination analysis was then performed to find risk profiles for outcomes.

Conclusion: In the university hospital, a weekend effect for many specialties for both emergency and elective admissions was observed. In the secondary hospitals, elective patients had a weekend effect for many specialties. Weekend elective procedures must be restricted to only those necessary to be performed on the weekend and guidelines for patient selection are needed. Before staffing is adjusted, more disease-specific research is needed to find which patients would benefit most.

ASA class and type of anesthesia did not affect the risk of outcomes in ENT day surgery but sex, type of procedure and age did. Female OHS patients with procedures under general anesthesia and requiring greater amounts of opioids in conjunction with surgery were undoubtedly linked with study outcomes. As type of anesthesia had no effect on study outcomes in ENT and OHS day surgery, local and regional anesthesia should be used when medically and procedurally possible. Overstay, readmission and contact rates were the same, or lower, than other international studies.

SUMMARY IN FINNISH

Tausta: Hoidon laadun seuraaminen lääketieteessä on hyvin tärkeää. Potilasturvallisuusongelmia voidaan parantaa tutkimalla vältettävissä olevia sairaalakuolemia ja kehittämällä toimintatapoja. Sitä kautta saadaan vihiä organisaatiotason ongelmista. Suurin osa hoidon laatuongelmista ei kuitenkaan aiheuta kuolemaa eikä suurin osa kuolemista johdu epäonnistuneesta hoidosta. Kaikista sairaalassa olevista potilaista kuolee 5-10 % ja 95-98 % kuolemista johtuu sairauksien luonnollisesta kulusta.

Sairaalakuolleisuuteen voi vaikuttaa jopa hoidon viikonpäivä, ns. viikonloppuilmiö (englanniksi weekend effect). Se tarkoittaa, että potilailla, jotka tulevat sairaalaan viikonloppuna, on suurempi kuolleisuus kuin arkipäivänä sisäänkirjoitetuilla. Suomessa on tutkittu viikonloppuilmiötä mm. tehohoitopotilailla, joilla esiintyi selvä viikonloppuilmiö, kun taas aivoinfarktipotilaiden liuotushoidossa tätä ei ole havaittu. Sairaalakuolleisuuteen liittyviä tekijöitä ei ole Suomessa aiemmin merkittävässä määrin tutkittu.

Korva-, nenä ja kurkkutautien erikoisalalla toimenpiteet ovat pääosin päiväkirurgisia. Yhdessä ortopedian ja käsikirurgian kanssa erikoisalat edustavat yli puolta päiväkirurgisista toimenpiteistä. Toimenpide sopii päiväkirurgiseksi, jos alle 3 % potilaista joutuu jäämään osastolle. Mikäli potilas ei kotiudu suunnitellusti toimenpiteen jälkeen, vaan joutuu jäämään osastolle (englanniksi overstay), potilaan valinta päiväkirurgiseen toimintaan katsotaan epäonnistuneeksi. Toisinaan potilas voi joutua tulemaan sairaalaan kotiutumiseen jälkeen, joko päivystykseen tai jopa osastohoitoon (englanniksi readmission). Näitä ns. readmissioita seurataan hoidon onnistumisen ja potilasturvallisuuden mittareina. Tutkimalla näitä readmissioita voidaan selvittää, onko päiväkirurgia laadukasta ja pyrkiä löytämään ne potilasryhmät, joiden hoidon turvallisuutta voisi vielä parantaa.

Tämän väitöskirjan tarkoituksena oli selvittää potilasturvallisuutta Suomen suurimmassa sairaanhoitopiirissä. Tutkimuksessa käytettiin kahta potilasturvallisuuden arvioinnissa hyvin tunnettua ja tutkittua indikaattoria, sairaalakuolleisuutta sekä readmissiota. Näiden indikaattorien seuraaminen antaa tietoa potilasturvallisuuden tasosta ja sitä kautta voidaan pyrkiä alentamaan kuolleisuutta sekä potilaiden haittatapahtumia sekä lisätä hoidon vaikuttavuutta.

Metodit: Kahdessa ensimmäisessä osatyössä tutkittiin sairaalakuolleisuuden ja ensimmäisen 30 kotiuttamisvuorokauden kuolleisuuden vaihtelua viikonpäivän mukaan Helsingin ja Uudenmaan sairaanhoitopiirin (HUS) alueella erikoisaloittain sekä elektiivisessä että päivystystoiminnassa vuosina 2000-2013. Nämä retrospektiiviset rekisteritutkimukset kattoivat kaiken kaikkiaan 1 998 906 osastohoidossa ollutta potilasta.

Kolmannessa ja neljännessä osatyössä tarkasteltiin päivystyskäyntejä ja osastohoitojaksoja 30 vuorokauden aikana päiväkirurgisen leikkauksen jälkeen sekä korva-, nenä- ja kurkkutautien että ortopedian ja käsikirurgian erikoisaloilla. Kaikista tammi-maaliskuun 2015 aikana Helsingin yliopistollisen sairaalan Korvaklinikan ja Herttoniemen sairaalan päiväkirurgisissa yksiköissä leikatuista potilaista kerättiin sähköisestä potilasjärjestelmästä seuraavat tiedot: ikä, sukupuoli, ASA-luokka, anestesiamuoto ja toimenpideryhmä. Kummankin yksikön 15 yleisintä toimenpidettä sisällytettiin tutkimukseen. Ortopedian ja käsikirurgian potilaista myös kerättiin perussairaudet, omat lääkitykset, painoindeksi, tupakointistatus ja leikkaukseen liittyvä lääkitys ja tiedot.

Tulokset: Sairaalakuolleisuuden viikonloppuilmiö havaittiin sisätautien, kirurgian ja naistentautien erikoisaloilla sekä yliopistollisessa että reunasairaaloissa. Lisäksi yliopistollisessa sairaalassa neurologian erikoisalalla oli nähtävissä viikonloppuilmiö. Viikonloppuilmiö havaittiin monella erikoisalalla elektiivisessä toiminnassa.

Korva-, nenä- ja kurkkutautien päiväkirurgisten toimenpiteiden jälkeen ”overstayn” tai readmission riskiä nostivat naissukupuoli, 16-64 -vuoden ikä ja nielu- tai kitarisatoimenpide. Näiden tapahtumien yleisimmät syyt olivat leikkausalueen verenvuoto sekä pahoinvointi tai oksentelu.

Ortopedian ja käsikirurgian päiväkirurgisten potilaiden toimenpiteiden jälkeen ”overstayn” riskitekijöiksi nousivat yleisanestesia ja vahvojen kipulääkkeiden suuri tarve. Suunnittelemattomien päivystyskäyntien ja readmissioiden riskiä nostivat naissukupuoli, vahvojen kipulääkkeiden määrä ja pahoinvointilääkkeen tarve. Näiden tapahtumien yleisimmät syyt olivat leikkausalueen tulehdus sekä pahoinvointi tai oksentelu.

Johtopäätökset: Yliopistosairaalassa viikonloppuilmiö esiintyi monella erikoisalalla, sekä päivystyspotilailla että elektiivisillä potilailla. Reunasairaaloissa ilmiö havaittiin usealla erikoisalalla elektiivisillä potilailla. On tarpeellista rajoittaa elektiivisiä toimenpiteitä viikonloppuisin ja potilasvalintakriteereitä olisi hyödyllistä tarkentaa. Ennen henkilöresurssien lisäämistä tautikohtainen tutkimus on tarpeen sen selvittämiseksi, mitkä potilaat hyötyisivät eniten resurssimuutoksista.

ASA-luokka ja anestesiamuoto eivät lisänneet haittatapahtumien riskiä korva-, nenä-ja kurkkutautien päiväkirurgiassa, mutta sukupuoli, toimeenpiteen tyyppi ja ikä lisäsivät. Naispotilailla, joille tehtiin ortopedian tai käsikirurgian päiväkirurgiaa yleisanestesiassa ja jotka tarvitsivat suuria määriä opioideja leikkauksen yhteydessä, on selvästi enemmän haittatapahtumia. Paikallispuudutusta ja regionaalista anestesiaa pitäisi käyttää mahdollisuuksien mukaan, koska anestesiamuoto ei lisännyt haittatapahtumien riskiä. ”Overstay”:den, readmissioiden ja kontaktien määrät olivat samalla, tai alemmalla, tasolla kuin kansainvälisissä tutkimuksissa.

CONTENTS

LIST OF ORIGINAL PUBLICATIONS

This thesis is based on the following publications:

I Tolvi M, Mattila K, Haukka J, Aaltonen LM, Lehtonen L. Analysis of weekend effect on mortality by medical specialty in Helsinki University Hospital over a 14-year period. *Health Policy*.2020;S0168-8510(20)30192-5. doi:10.1016/j.healthpol.2020.07.010

II Tolvi M, Mattila K, Haukka J, Aaltonen LM, Lehtonen L. Weekend effect on mortality by medical specialty in six secondary hospitals in the Helsinki metropolitan area over a 14-year period. *BMC Health Serv Res*. 2020;20(1):323. doi:10.1186/s12913-020-05142-4

III Tolvi M, Lehtonen L, Tuominen-Salo H, Paavola M, Mattila K, Aaltonen LM. Overstay and Readmission in Ear, Nose, and Throat Day Surgery – Factors Affecting Postanesthesia Course [published online ahead of print, 2019 Oct 3]. *Ear, Nose Throat J*. 2019; 145561319872165. doi:10.1177/0145561319872165

IV Tolvi M, Tuominen-Salo H, Paavola M, Mattila K, Aaltonen LM, Lehtonen L. Root causes of extended length of stay and unplanned readmissions after orthopedic surgery and hand surgery: a retrospective observational cohort study. *Patient Saf Surg*. 2020;14:27. doi:10.1186/s13037-020-00249-3

The publications are referred to in the text by their Roman numerals and are reprinted with the permission of their copyright holders.

ABBREVIATIONS

AHRQ	Agency for Healthcare Research and Quality
AMI	acute myocardial infarction
ASA	American Society of Anesthesiologists
BMI	body mass index
CABG	coronary artery bypass graft
CCG OIS	Clinical Commissioning Group Outcomes Indicator Set
CCI	Charlson comorbidity index
CI	confidence interval
CMC	carpometacarpal
CMR	cumulative mortality rate
COPD	chronic obstructive pulmonary disease
DHBP	dehydrobenzperidol
DIP	distal interphalangeal
DRG	diagnosis-related group
e.g.	*exempli gratia* (for example)
ENT	ear, nose and throat
etc.	*et cetera* (and so forth)
EU	European Union
GDPR	General Data Protection Regulation
GI	gastrointestinal
HaiPro	adverse event reporting process (*haittatapahtumien raportointiprosessi*)
HILMO	Care Register for Health Care (*hoitoilmoitusjärjestelmä*)
HMI	hospital mortality indicator
HRRP	Hospital Readmissions Reduction Program
HSMR	hospital standardized mortality rate
HUS	Helsinki and Uusimaa Hospital District (*Helsingin ja Uusimaan sairaanhoitopiiri*)
HYKS	Helsinki University Hospital
ICD	International Classification of Diseases
ICU	intensive care unit
i.e.	*id est* (that is)
IHI	Institute for Healthcare Improvement
IQR	Hospital Inpatient Quality Reporting program
i.v.	intravenous
JCI	Joint Commission International
LMDRG	low mortality diagnosis-related group
NHS	National Health Service

NOAC	novel oral anticoagulant
NOMESCO	Nordic Medico-Statistical Committee
NPV	negative predictive value
NRS	numeric rating scale
NSAID	nonsteroidal anti-inflammatory drug
NSTEMI	non-ST segment elevation myocardial infarction
OECD	Organisation for Economic Co-operation and Development
OHS	orthopedic and hand surgery
OR	odds ratio
PaSQ	European Union Network for Patient Safety and Quality of Care
PCI	percutaneous coronary intervention
PONV	postoperative nausea and vomiting
PPV	positive predictive value
RSRR	risk standardized readmission rate
SHs	secondary hospitals
SIRO	Hospital Infections Registry (*Sairaalainfektioiden rekisteriohjelma*)
THL	Finnish Institute for Health and Welfare (*Terveyden ja hyvinvoinnin laitos*)
UPPP	uvulopalatopharyngoplasty
US	United States
USD	United States dollar
WHO	World Health Organization

1 INTRODUCTION

In the field of medicine, the monitoring of the quality of care is essential. By researching avoidable hospital deaths and improving strategies, one can improve patient safety and get wind of hospital-wide problems. Most quality of care problems do not cause death and most deaths are not caused by failed treatment[1]. Of all hospital inpatients, 5-10% die and of these deaths, 95-98% are due to the natural course of disease[2,3].

Even the day of the week of hospital admission can affect the risk of hospital mortality[4]. The weekend effect is defined as the phenomenon of patients admitted to hospital during the weekend having a higher risk of death than those admitted during the week[4]. In Finland, only few studies on the weekend effect have been performed: in intensive care unit (ICU) patients, who had a weekend effect[5], and in the thrombolysis of stroke patients, who had no effect[6]. There has been little research on hospital mortality in Finland in general.

More than half of day surgery procedures performed in Finland are in the specialties of ear, nose and throat (ENT) diseases and orthopedic and hand surgery (OHS)[7]. As a general guideline, a procedure is considered appropriate to be performed as day surgery if postoperative admission to the ward is less than 3%[8]. Problems in recuperation may arise, causing patients to attend the emergency department or be admitted for treatment or observation. These events are monitored as measures of successful health care and patient safety[9]. By examining these unplanned episodes of care, the worthwhileness of day surgery can be critiqued and patient groups, whose safety could be improved, can be found.

The aim of the present study was to probe into patient safety at the largest hospital district in Finland via hospital mortality and overstays, readmissions and contacts after day surgery. By analyzing these problems, we gain information on the phenomena. Mortality and adverse events can then be reduced, and efficiency increased.

2 REVIEW OF THE LITERATURE

2.1 PATIENT SAFETY

The World Health Organization (WHO) defines patient safety as:

> *'the absence of preventable harm to a patient during the process of health care and reduction of risk of unnecessary harm associated with health care to an acceptable minimum.'*[10]

Definitions of key terms in patient safety:

> ***Adverse event:*** *An injury related to medical management, in contrast to complications of disease. Medical management includes all aspects of care, including diagnosis and treatment, failure to diagnose or treat, and the systems and equipment used to deliver care. Adverse events may be preventable or non-preventable*[11].
>
> ***Patient safety incident:*** *Any unintended or unexpected incident that could have or did lead to harm for one or more persons receiving health care*[12].
>
> ***Near-miss or close call:*** *Serious error or mishap that has the potential to cause an adverse event but fails to do so because of chance or because it is intercepted. Also called potential adverse event*[11].

Patient safety can be divided into medication safety, medical device safety and treatment safety (Figure 1). Medication safety is both the safety of the medicine itself, as well as the safety of medicating patients i.e. errors in dosage or omission of medication. Medical device safety involves the safety of the devices and the safety of their use, and treatment safety the safety of treatment methods and processes[13]. Barriers are in place to prevent the occurrence of patient safety incidents. These barriers vary greatly and include, for example, hand sanitizer, WHO Surgical Check List and interaction warnings for electronic prescriptions[10].

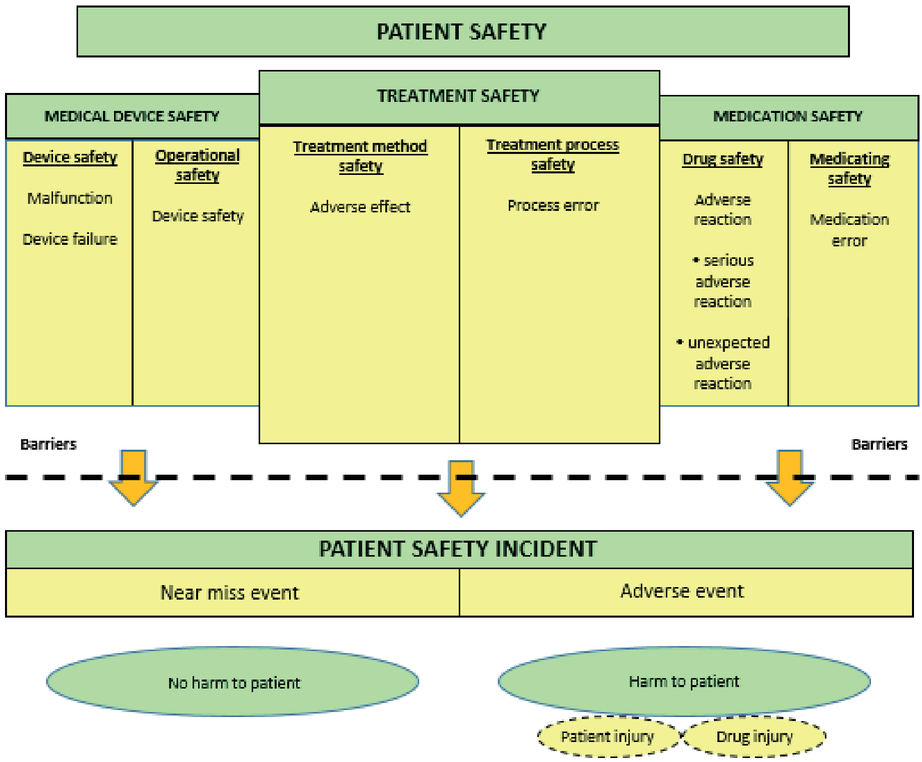


Figure 1 Patient safety. Modified from Stakes & Rohto 2006. Potilas- ja lääkehoidon turvallisuussanasto (Patient and Medication Safety Glossary)[14].

To fully comprehend the magnitude of patient safety issues and costs, it is important to examine the breadth of all the areas it involves. WHO estimates that medication errors cost 42 billion United States dollars (USD) annually[15]. Medication Without Harm is the latest theme – launched in 2017 - in the Global Patient Safety Challenge of the WHO. Polypharmacy, high-risk situations and transitions of care are listed as key action areas[16]. The goal of the Medication Without Harm challenge is to decrease severe preventable medication-related events by 50% by 2022[17].

As many as four in ten patients experience adverse events in outpatient care. These failures in safety cost approximately 2.5% of total health expenditure and possibly more than 7 million admissions in the Organisation for Economic Co-operation and Development (OECD) countries[18].

In hospitals in low- and middle-income countries, 134 million adverse events take place yearly, factoring in to 2.6 million deaths per year due to unsafe care, and costing 1.4-1.6 trillion USD per year[19]. The Finnish Institute for Health and Welfare (THL) estimates one in ten hospital patients suffers an adverse event and 700-1,700 die every year due to adverse events[20].

Primum non nocere, “first, do no harm”, is a fundamental principle of medicine and set forth the idea of patient safety. The history of modern patient safety, however, is much shorter[21]. In 1999, the United States (US) Institute of Medicine released its report *To Err is Human: Building a Safer Health System*, sparking the patient safety movement. It introduced the idea that healthcare industry errors are mostly systemic and preventable medical errors that cause the death of 44,000 to 98,000 patients a year in the US alone[22].

WHO began its patient safety program in 2004, establishing policies and training programs on the subject[10]. WHO estimates an average of one in ten patients is harmed during hospital care[23]. WHO spearheaded the implementation of the Surgical Safety Checklist as part of the Safe Surgery Saves Lives program[24]. During the study, the checklist reduced the death rate from 1.5% to 0.8% and complication rate from 11.0% to 7.0%[25].

Patient safety was brought to the European Union (EU) agenda through the adoption of the Luxembourg Declaration on Patient Safety, which recommended cooperation between EU Member States and with WHO, as well as set forth proposals for safety in medical technology, patient data protection and informed consent[26]. Launched in 2012, the objective of the European Union Network for Patient Safety and Quality of Care (PaSQ) is to support cooperation between European Member States in implementing European Council recommendations on patient safety[27]. The WHO launched a global patient safety campaign on September 17, 2019, the first-ever World Patient Safety Day[28].

According to estimates, adverse medical events cost the Finnish healthcare system approximately 400 million euros a year[29]. However, this does not include outpatient and long-term care or the expenses to the patients and their employers through loss of income. When factoring in outpatient and long-term care, this number climbs to around 951 million euros[29]. In addition, the Finnish Patient Insurance Centre (*Potilasvakuutuskeskus*) paid 40.7 million euros in 2018 due to patient injuries[30]. This totals almost 1 billion euros due to adverse medical events in a small country of just over 5 million people, in other words approximately 5% of healthcare costs (20.6 billion euros in 2017)[31] or 0.45% of the gross domestic product of Finland (223.9 billion in 2017)[32]. Needless to say, these are naturally only estimates; the actual price to society is difficult to approximate.

The first National Patient Safety Strategy (*Kansallinen potilasturvallisuusstrategia 2009-2013*) was compiled for 2009-2013 and updated in 2017 to the Patient and Client Safety Strategy for 2017-2021[33,34]. The strategy approaches quality and patient and client safety from four angles: safety culture, responsibility, leadership and laws[33]. The Health Care Act (*Terveydenhuoltolaki* 1326/2010)[35] was issued December 30, 2010 and went into effect on May 1, 2011. In regard to quality and patient safety, Section 8 states

> *"The provision of health care shall be based on evidence and recognized treatment and operational practices. The health care provided shall be of high quality, safe, and appropriately organized. The primary healthcare providers of local authorities shall ensure that all aspects of patient care are coordinated, unless otherwise agreed. Each healthcare unit shall produce a plan for quality management and for ensuring patient safety. The plan shall include arrangements for improving patient safety in cooperation with social services".*

THL published the Patient Safety Guide (*Potilasturvallisuusopas*) in 2011[34]. The main goals of the guide were to support the implementation of patient safety legislation and aid healthcare organizations in planning their patient safety strategies[34].

2.2 PREVENTABLE ADVERSE EVENTS

There are five types of preventable adverse events: errors of commission, of omission, of communication, of context and diagnostic errors[36]. An error of commission occurs "*when a mistaken action harms a patient either because it was the wrong action, or it was the right action but performed improperly*"[36]. Errors of omission are "*when an obvious action was necessary to heal the patient, yet it was not performed at all*"[36]. For example, the patient needed a certain medication, which was not prescribed, thus ending in the patient's death[36]. Errors of communication occur either between healthcare providers or between healthcare provider and patient[36]. Errors of context "*occur when a physician fails to take into account unique constraints in patient's life that could bear on successful, post-discharge treatment*"[36]. An example of this would be entrusting a patient with severe dementia to act in accordance with a complex medication plan[36]. Diagnostic errors can cause ineffective, incorrect or delayed treatment[36].

As previous means of approximating preventable adverse events often gauged estimates much lower than reality, the Institute for Healthcare Improvement (IHI) developed the Global Trigger Tool for Measuring Adverse Events[37,38]. This method uses a two-stage manual retrospective chart review by reviewers trained in the method and utilizes clues, or “triggers” (e.g. abnormal laboratory results), to find adverse events. If a trigger is found, the chart is reviewed for an adverse event[39].

Since 2007, the Finnish HaiPro (*haittatapahtumien raportointiprosessi,* adverse event reporting process) system has been used to report patient safety incidents in health care[20]. It is used by over 300 social and health care organizations[20]. As of 2017, over 1 million HaiPro reports have been submitted, with doctors filing 2% of these reports[20]. However, according to Rauhala et al, doctors’ reports more often concerned serious adverse events than nurses’[20]. Most reports were connected with medicine and fluid treatment (43.5%), second most accidents (22.6%) and approximately one-third were near miss events[20].

2.3 SYSTEMS THINKING AND THE SWISS CHEESE MODEL OF SAFETY INCIDENTS

In health care, traditionally when an adverse event occurred, the individual was blamed without examining the reasons why the event was able to ensue. In fear of sanctions, employees often tried to cover up their mistakes. Instead, in the model of systems thinking, the reason why the adverse event occurred is examined. In other words, what is wrong with the system, which allowed a mishap to take place? Both approaches have their weaknesses. Blaming the employee risks patient safety by encouraging cover-ups, while blaming the organization risks patient safety by forgetting the responsibility of the employee[21]. In 2000, Albert Wu coined the term “second victim” for healthcare workers suffering psychologically after an adverse event[40] and Rassin et al theorized that this suffering is a form of post-traumatic stress disorder[41]. Popularization of the term has brought opposition from patient advocates, with Wu stating that maybe the term should be abandoned[42].

Psychologist James Reason developed the Swiss cheese model as a way of visualizing how safety barriers fail and accidents occur. In this model, there are weaknesses in the barriers, which are represented by the holes in the Swiss cheese. When enough of these holes line up, an adverse event occurs (Figure 2). These weaknesses are either active or latent failures. Active failures are usually temporary and are mistakes, forgetfulness or misjudgment. Latent failures are usually on an organizational level and may be latent until they combine with active failures or local risk factors, enabling adverse events[21].

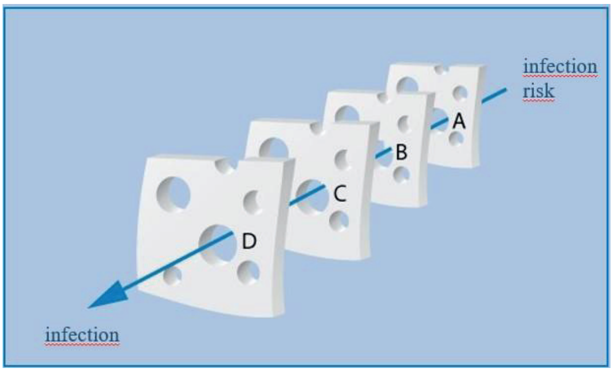


Figure 2 **The Swiss cheese model** presents an example of the failure of barriers preventing infection. **A.** An operation begins late, causing the preparations to be made in haste. **B.** The patient has a comorbidity that increases their risk of infection. **C.** Due to haste, the surgical checklist was not implemented and antibiotic prophylaxis was forgotten. **D.** The duration of the operation was longer than planned. *Modified from Aaltonen L-M and Rosenberg, P (toim.) Potilasturvallisuuden perusteet, Kustannus Duodecim Oy 2013 with permission*[21].

2.4 PATIENT SAFETY INDICATORS

According to Roine and Kaila, the most important component of patient safety is the effectiveness of treatment[43]. They postulated that treatment, which is not effective, cannot be safe because it exposes the patient to the possible harm of the treatment without even a theoretical benefit[43]. Methods, treatment and equipment used in health care must be based on evidence and this evidence must be acquired through research[43]. Before implementation, research must be done in regard to efficacy and safety[43].

There is a long list of indicators chosen as benchmarks of quality in health care. Table 1 shows the most commonly used indicators in Finland. For this work, mortality and readmission were chosen as they are concrete concepts with universally accepted definitions and are centrally important as measurements of patient safety in the hospital environment.

Patient safety indicators
Complaints, compensable patient injuries
Hand sanitizer use
Staff influenza vaccinations
Hospital mortality
30-day post-discharge mortality
Readmission
Unplanned reoperation rate
Use of surgical check list
Infection due to medical care
Registry indicators
Care Register for Health Care (HILMO) (THL)
Implant registry (THL)
Cause of death registry (Statistics Finland)
Adverse reactions to medications registry (Finnish Medicines Agency)
Adverse reactions to vaccines registry (THL)
Hospital infections registry (SIRO)
Abnormal radiation incident registry (Radiation & Nuclear Safety Authority)
Blood transfusion reactions registry (Blood Safety Office)
Medical device incidents registry (Finnish Medicines Agency)
Patient injury database (Patient Insurance Centre)
Complaints registry (Valvira)

Table 1. The most commonly used patient safety and registry indicators in Finland. THL = Finnish Institute for Health and Welfare.

2.4.1 MORTALITY

In the field of medicine, quality control and monitoring are crucial. Medical professionals strive to offer patients care of the upmost quality. But how do we measure quality? By investigating hospital mortality and developing better methods, patient safety can be improved. Most quality of care problems do not cause death and most in-hospital deaths are not caused by poor care[1]. Of all in-hospital patients, 5-10% die. Of these deaths, 95-98% are just the natural course of disease, not sub-standard quality of care[2,3]. Even a detail as seemingly irrelevant as the day of the week of admission can affect hospital mortality[4].

Across Europe, the surgical mortality in 498 hospitals in 28 countries over the course of one week was examined by Pearse et al[44]. Four percent died in hospital, with the lowest in Iceland (1.2%) and the highest in Latvia (21.5%). After adjusting for various factors, Finland's surgical mortality was the lowest (adjusted odds ratio (OR) 0.44, Britain OR=1) and Poland's the highest (adjusted OR 6.92). These results were called into question by the Latvian Anesthesiologist Association, which calculated a mortality rate of 0.66%, not 21.5%, for the same period of time[45]. A Polish anesthesiologist (Franek) collected patients for the original study and reported a mortality rate of 0.5%. The extrapolation of the mortality rate of six Polish hospitals during one week into a mortality rate for the entire country was also disparaged by Franek et al[46]. Doubt was cast on the correctness of using 100 British hospitals as a benchmark to compare, for example, to 6 Polish hospitals by van Schalkwyk's and Brodner's teams[47,48]. The Irish researchers of Doherty et al redid the study and found a mortality rate of 2.5% (versus Pearse's 6.4%) and adjusted OR 0.70 (Pearse 1.86)[49].

In order to measure mortality, first one must define mortality[50]. In other words, does the measure only cover deaths during hospital stay, or also those after discharge[50]? If limiting the study to only deaths in hospital, one risks missing deaths linked to hospital care after discharge[50]. Second, the patient cohort must be identified, and inclusion or exclusion criteria set[50]. For example, some studies exclude palliative patients, neonates, hospital patient transfers, multiple admissions or those discharged against medical advice or after less than one day, some only a specific diagnosis or condition[50].

Many problems have been set forth by various researchers as plaguing the measurement of hospital mortality: the inaccuracy of administrative data, risk adjustment for comorbidities and disease severity, the lack of predictivity models and their validation, comparisons between studies and hospitals and the use of results for deciding funding and collaboration with insurance companies, just to name a few[50–56]. If the assumption is made that risk is constant over time, and it is not, then case-mix adjustment may increase bias. This is known as "constant risk fallacy" and studies for and against the existence of this fallacy have been published[56,57].

Factors connected with in-hospital mortality, e.g. variability between hospitals and seasonal variability, have not been widely investigated in Finland.

Hospital mortality is used as a quality care indicator in many Western countries. Britain, Sweden, Holland, Canada, the US and Australia use the hospital standardized mortality ratio (HSMR) to evaluate the quality of care given in hospitals[1]. Forster and van Walraven postulated that it is rather difficult to draw conclusions about differences in patient data based solely on HSMR[58]. According to an Australian study, a high HSMR does not necessarily speak of low-quality care[1]. HSMR does not take into account disease severity[58]. However, diagnosis-specific HSMR may be more beneficial as an indicator for assessing common diseases and diseases with a high risk of death according to an Australian study[1]. Differences in case mix (i.e. the mix of patients treated)[59], for example, are difficult to infer on the basis of HSMR. At the same time, HSMR can be informative in regard to larger hospital-wide problems, by way of illustration hospital infections or communication problems during shift changes. A Dutch study found an HSMR model that measured quality of care well[60]. It included primary diagnosis, age, sex, urgency of care, length of hospital stay, comorbidity using the Charlson Index, socioeconomic status, month and unit of referral. A later study found the cumulative mortality ratio (CMR), which measures death within 30 days of admission, to be more precise in finding deaths than Jarman's method of HSMR[60], which obtained higher mortality rates[61]. Jarman also previously stated that HSMR "measures mortality, not preventable mortality"[62].

Lujic et al. found that models with 30-day definitions had lower mortality rates than average in-hospital HSMRs[63]. The Scottish National Health Service's (NHS) version of HSMR calculates mortality 30 days from admission, with the idea being that decisions made at admission influence the outcome of treatment[64].

In the US, the Agency for Healthcare Research and Quality (AHRQ) has approved the mortality in seven surgical procedures as an indicator of hospital quality[65]. These seven procedures are abdominal aortic aneurysm repair, esophageal resection, hip replacement surgery, coronary artery bypass graft (CABG), pancreatic resection, pediatric heart surgery and craniotomy[65]. An American study postulated that because these procedures are highly complex and are centralized to tertiary care centers, most of these procedures are performed minimal times per year, causing insignificant sample sizes[66]. Dimick et al found that, with the exception of CABG, the operations are too scarce to be used for the tracking of mortality and evaluation of quality of care[66]. Mortality during previous years was found by Birkmeyer to be a better indicator than surgical volume in the future[67]. However, in regard to esophageal resection, the operation volume of the surgical unit was a more important benchmark for predicting future mortality than previous mortality according to Birkmeyer's findings[68].

In general, palliative patients are removed from HSMR calculations[69]. A Canadian study, however, pondered whether this causes the manipulation of HSMR results by changing practices in the coding of diagnoses[69]. In both Britain and Canada, the number of palliative patients has doubled since the start of publishing HSMR results[69,70]. Changes in the coding of diagnoses have correspondingly improved the HSMR results of these hospitals[69,70]. Due to these circumstances, the Department of Health in England began to use the summary hospital-level mortality indicator, which includes all palliative patients and deaths within 30 days of discharge from the hospital[71].

Low mortality diagnosis-related group (DRG) hospital mortality indicator (LMDRG HMI) includes patients belonging to DRGs with less than 0.5% mortality and excludes patients younger than 18 years old or admitted for trauma, cancer or immunodeficiency[72]. Risk adjustment varies from country to country[72]. An Australian review found that most studies on this indicator were of rather low quality with feeble and conflicting associations with quality of care and that LMDRG HMI is best suited to screening purposes[72].

There are multiple problems in estimating the amount of preventable hospital deaths[73]. Many studies have used a handful of reviewers (one to three) to evaluate a handful of medical charts[73]. These evaluations, however, are rather subjective and medical records may be lacking important information in regard to the last moments of the patient before death[73,74]. Another problem, found by Shojania et al, is if one reviews a small portion of medical charts, the results cannot be extrapolated for entire hospitals or countries and in completely different populations than the original study[75]. Another problem, considered by Hayward's study, is the dichotomizing of deaths into either avoidable or not avoidable when rarely is anything so black and white in medicine[76]. A continuous scale was considered more appropriate by Hayward[76]. Hogan et al. estimated 5.2% of hospital deaths, or 11,859 deaths, to be preventable in England[77].

2.4.2 READMISSION

Hospital readmissions are used as a quality indicator in health care, even though readmission rates are not a quality benchmark *per se*[9]. Readmission rates measure the utilization of health services, not the health of patients. While naturally the health of patients does, in turn, affect their use of services, access to these services, socioeconomic factors and continuity of care after readmission are also significant aspects to readmission[9,78]. Use of readmission as a quality indicator requires defining the type of index admission and readmission being examined[79]. Is the index admission elective or emergency, medical or surgical or a hospital transfer? Often patients leaving hospital against medical advice are excluded from readmission rates. If examining the readmission rate of a chronic illness, readmissions may be connected to a natural progression of the disease, not poorness of care. Approximately 23% of readmissions are avoidable according to a Canadian meta-analysis of urgent 30-day readmissions[80]. When examining readmissions, the follow-up time must be chosen with the disease in mind: too long of a window allows readmissions connected to natural progression of the disease to be included, too short of a window misses some readmissions[81]. Twenty-eight to 31-day windows are most commonly used[79]. Some readmission rates examine all-cause readmission, some only those readmissions related to the index admission[82].

In the United States, the Patient Protection and Affordable Care Act of 2010 (also known as "Obamacare") brought about the Hospital Readmissions Reduction Program (HRRP), which aims to reduce readmissions and hospital mortality[83]. Thirty-day risk standardized readmission rates (RSRRs) are used as a measure[84]. Medicare and Medicaid Services inflict penalties on hospitals with high 30-day post-discharge readmission rates[85]. However, in the case of heart failure and pneumonia patients[86], there was an increase in 30-day and 1-year mortality but a decrease in 30-day and 1-year readmissions[87]. Moreover, allegations of working the system abound: suspicions of upcoding, keeping patients under observation instead of admitting them and delaying readmission over the 30-day mark have been presented[88]. Intimations of prevented readmissions really just being readmissions postponed over the 30-day mark have also been broached[87].

Readmission rates and mortality rates do not necessarily travel hand-in-hand and in fact, may have no relationship between them at all according to an English study[89]. Consequently, these measures should be examined together in order to obtain a more accurate overview of hospital performance[90].

In order to reduce readmissions, first one must find those that are avoidable. The criteria and methods for defining avoidable readmissions are widely varying and subjective[82]. The Australian Commission on Safety and Quality in Health Care defines avoidable hospital readmission as:

> *"An avoidable hospital readmission occurs when a patient who has been discharged from hospital (index admission) is admitted again within a certain time interval, and*
>
> - *the readmission is clinically related to the index admission, and*
> - *the readmission has the potential to be avoided through improved clinical management and/or appropriate discharge planning in the index admission[91]."*

The number of readmissions judged as avoidable has fluctuated greatly from one study to the next, as low as 5.0%[92] and up to 78.9%[93], depending on inclusion criteria. Readmissions are not a valid way of measuring hospital and care quality if one examines unavoidable readmissions. A recent review criticized the number of studies using only one reviewer – 17 out of 31 studies – as the avoidability of readmissions is often subjective[82]. Fifteen percent of avoidable readmissions are thought to be due to system factors – e.g. inadequate discharge planning, lack of care coordination, communication problems – and over 40% due to clinician factors – e.g. premature discharge or diagnostic errors[94].

Some countries have initiated readmission prevention programs with varying benchmark conditions. In the US, the Hospital Inpatient Quality Reporting program (IQR) follows 30-day readmissions after acute myocardial infarction (AMI), chronic obstructive pulmonary disease (COPD), CABG, heart failure, pneumonia, ischemic stroke, total hip and knee arthroplasty and hospital-wide all-cause readmission[95].

The Clinical Commissioning Group Outcomes Indicator Set (CCG OIS) in England is comprised of 3 indicators: emergency readmissions within 30 days of discharge from hospital, emergency alcohol-specific readmission to any hospital within 30 days of discharge following an alcohol-specific admission, and unplanned readmissions to mental health services within 30 days of a mental health inpatient discharge in people aged 17 and over[96].

The hospital care indicator set of the Compendium of Population Health indicators examines emergency readmissions to hospitals within 28 days of discharge for fractured proximal femur, stroke, hysterectomy, primary hip replacement surgery and all-cause emergency 30-day readmission in the NHS[97–99]. The Scottish heart disease indicator set scrutinizes emergency readmission within 30 days of emergency admission for congestive heart failure, heart attack, angioplasty or CABG, or within 30 days of elective admission for angioplasty or CABG[100]. Canada follows 30-day readmission rates after AMI, for mental illness, obstetrics, patients aged 17 and younger, surgical and medical readmission, as well as 30-day all-cause readmission after isolated CABG and percutaneous coronary intervention (PCI)[101–109].

The Australian Commission on Safety and Quality in Health Care developed a list of conditions considered to be avoidable readmissions. This list includes pressure injuries, infections, surgical complications (hemorrhage, wound dehiscence etc.), respiratory complications, venous thromboembolism, renal failure, gastrointestinal bleeding, medical complications (hypoglycemia, drug related respiratory complications or depression), delirium, cardiac complications, constipation and vomiting[91]. Each of these conditions has been assigned a time interval from the index admission when valid[91]. Regardless of how one defines avoidable readmissions and which conditions are included, it is essential from both a patient safety and financial aspect to reduce them.

2.5 WEEKEND EFFECT

Research has shown that even the day of the week a patient is admitted can affect hospital mortality. This phenomenon is referred to as the weekend effect, which means that patients admitted on the weekend are more likely to die than those admitted during the week[4]. Despite being widely investigated, the reasons behind the effect remain somewhat of a mystery[110].
A weekend effect has been found for acute non-variceal upper gastrointestinal (GI) hemorrhage[111], ICU patients[5,112], acute pulmonary embolism[113], peptic ulcer-related hemorrhage[114], heart failure[115] and acute leukemia[116]. Upper GI hemorrhage patients admitted at the weekend were also more likely to undergo surgery[114]. The lack of a weekend effect has been documented in COPD[117], esophageal variceal hemorrhage[118] and subarachnoid hemorrhage[119]. Varying results have been presented for stroke[120–123], intracerebral hemorrhage[117,119,124], AMI[117,125–128] and hip fracture[117,129–131]. A Portuguese study found no weekend effect among patients suffering from acute bacterial pneumonia[132]. A significant weekend effect was found for pulmonary embolism patients in Italy[133]. A previous study at the stroke unit of Helsinki University Hospital did not find a weekend effect[6]. However, a weekend effect for stroke patients has been found elsewhere[134]. Only a small number of Nordic studies have been performed[6,128,130,135–137].

The weekend effect in obstetrics patients has been widely researched but results have been conflicting[138–144]. Internal medicine patients[145] and elective surgical patients[146] experienced a weekend effect.

A 3-10% higher mortality risk was found for emergency patients admitted during the weekend[147,148] and 14% higher if admitted at night during the weekend[149]. A similar result was recorded for emergency and urgent admissions across various diagnoses[146,150]. Thirty-day mortality was higher for elective surgery patients on Fridays and at the weekend[151]. One study found higher in-hospital mortality for all out-of-hours admissions, in addition to Mondays and nights[152]. In addition, major teaching hospitals had higher weekend effect risks for emergency patients[153,154]. Many factors have been considered for the weekend effect: the decrease of elective patients at the weekend[155], ambulance transport to the emergency room[156] and more severely sick patients at the weekend[157,158]. However, after factoring in severity of illness, the weekend effect persisted[159]. This was also shown in a recent systematic review and meta-analysis[4]. Other patterns of mortality at different times of the day also exist[160].

Only a few weekend effect studies have been performed in Finland. Weekend admissions lead to higher mortality in ICU patients. ICU patients die most likely in the evening and at night[5]. The Helsinki Stroke Thrombolysis Registry Group investigated the effect of the time of day and the doctor's experience on the treatment of stroke patients receiving thrombolytic therapy and found no diurnal or seasonal effect on door-to-needle time or clinical outcome[6].

2.6 DAY SURGERY

Day surgery, also known as ambulatory, outpatient, day case or same-day surgery, is planned, elective surgery, which is carried out on the same day as the patient is admitted and discharged[161]. Patients are discharged after a short recovery period. In the US, as of 2016, 67% of surgical procedures were outpatient[162]. James H. Nicoll, the father of modern day surgery, began employing day surgery practices in 1899 and by 1908 reported a total of 8,988 operations[163]. However, the practice of day surgery was slow to catch on and began to become more common during the late 1970s and early 1980s[164]. Helsinki and Kuopio University Hospitals were the sites of the first day surgery in Finland in the 1970s[165]. Advancements in surgical procedures and invasiveness, as well as anesthesia methods and proficiency, have expanded the list of operations appropriate for day surgery. The cost of the same procedure as day surgery as opposed to as an inpatient procedure is 25-68% less expensive[161].

The field of day surgery is constantly expanding with an increasing amount of procedures being carried out as day cases worldwide. In 2018, 91,558 operations were performed in the Helsinki and Uusimaa Hospital District (HUS), of which 36,897 were performed as day surgery[166]. Of these day surgery procedures, 28,439 (52.9% of elective surgeries) were carried out in Helsinki University Hospital[167].

The ASA Physical Status Classification, or ASA class, is a classification for evaluating the health of a patient before an operation. It has six categories: ASA I-VI. The classification is defined as follows: ASA I – a normal healthy patient, ASA II – mild systemic disease, ASA III – severe systemic disease, ASA IV –

severe systemic disease that is a constant threat to life, ASA V – moribund patient who is not expected to live without the operation and ASA VI – a declared brain-dead patient whose organs are being removed for donor purposes[168].

2.6.1 EAR, NOSE AND THROAT DAY SURGERY

In some countries, for example Austria, ENT procedures like tonsillectomies are still performed as inpatient surgery[169]. Day surgery, however, has been embraced in Finland and ENT is the second most frequent specialty in day surgery, comprising up to 28%[7]. In 2000, 13% of tonsillectomies in Finland were performed as day surgery[170]. This figure rose to 67% in 2010 and in our data is 92.3%. Amongst OECD countries, the majority still perform the bulk of tonsillectomies as inpatient surgery as of 2017[171].

ENT procedures are mainly day surgery. Sometimes unforeseen complications occur, and patients have to return to the hospital or are not able to be discharged after a day surgery procedure. Readmission rates should remain under 2-4% in order for day surgery to persist in being practical and cost-effective[8,172].

Singh et al. found an overstay rate of 9.62% and a readmission rate of 2.88% in nasal day surgery, with epistaxis (28.9%) and postoperative pain (23.7%) as the most common reasons[173]. Readmission rates of 2.0-3.1% have been encountered in recent studies[174–176] and vomiting, hemorrhage and inadequate recovery from anesthesia as the most common reasons for readmission[175]. In children, ENT surgery, as well as age of less than 2 years, were risk factors for readmission[177]. A readmission rate of 5.1% was found for day patients undergoing stapes surgery, with the main reason for readmission being dizziness and nausea[178].

Jain et al. found the most readmissions occurred after five ENT operations: total or subtotal thyroidectomy (7.4%) with limited neck dissection due to malignancy, cervical lymphadenectomy (modified radical neck dissection) (5.6%), uvulopalatopharyngoplasty (UPPP) (3.4%), tonsillectomy and adenoidectomy (age 12 years or older) (3.1%) and glossectomy (less than half of the tongue) (3.0%)[176]. Of these procedures, only tonsillectomy and adenoidectomy are performed as day surgery at Helsinki University Hospital. The study also found a readmission rate of 2.0% for day surgery patients, compared with 4.8% for inpatients. This was most likely due to simpler procedures and healthier patients in the day surgery cohort.

2.6.2 ORTHOPEDIC AND HAND DAY SURGERY

Orthopedic surgery is the most common day surgery specialty in Finland, comprising up to 55% of all procedures[7]. Hand surgery is the fourth most common, after orthopedic surgery, ENT and gynecology and obstetrics, comprising up to 23%[7].

In a large, multi-specialty US study, orthopedic day surgery was the second most common day surgery specialty. Readmission rates of 1.2-2.5%[174,176] and overstay rates of 0.1-0.8%[179,180] have been found, with pain and bleeding being the most common reasons for overstay and readmission[174,180–182]. A recent Spanish study found an overstay rate as high as 1.5% but a readmission rate of 0.3%[183]. In this Spanish study, overstay was due to pain, nausea or wound complications, and readmission was most commonly due to wound infection. Jimenez Salas et al. found overstays to be related to general anesthesia, longer procedures, as well as arthroscopy, hallux vagus surgery or removal of osteosynthesis material[183]. Carpal tunnel release patients have an operation site infection rate of 0.36%[184]. Prophylactic antibiotic use had no effect on the infection rate, not even in diabetics[184].

3 AIMS OF THE STUDY

The general objective of this thesis was to probe into patient safety at the largest hospital district in Finland via the weekend effect on in-hospital and 30-day post-discharge mortality, as well as overstays, readmissions and contacts after day surgery. By examining these indicators, we can gain more knowledge on the subject, advance patient safety and better allocate resources to the most at risk patients in health care.

The specific aims of this research were to investigate patient safety by retrospectively analyzing:

1. the variation of hospital mortality for weekend admissions between different specialties according to urgency of admission for both Helsinki University Hospital (Study I) and the secondary hospitals of HUS (Study II)
2. overstay, 30-day readmissions and contacts after ENT day surgery (Study III)
3. overstay, 30-day readmissions and contacts after OHS day surgery and investigating the perioperative factors affecting these outcomes to find patient profiles more prone to complicated recuperation after day surgery (Study IV)

4 STUDY POPULATION AND METHODS

4.1 DEMOGRAPHICS OF HELSINKI AND UUSIMAA HOSPITAL DISTRICT

The specific catchment area of HUS was 1.6 million inhabitants as of 2013, the end of this study. In 2013, 508,949 individual patients were treated[185]. Now the population of the catchment area has grown to 2.2 million and 614,169 individual patients treated in 2018[166].

HUS provides treatment in 23 hospitals. Helsinki University Hospital comprises Meilahti Tower Hospital, Meilahti Triangle Hospital, New Children's Hospital, Women's Hospital, Comprehensive Cancer Center, Psychiatric Consultation Outpatient Clinics, Surgical Hospital, Töölö Hospital, Skin and Allergy Hospital, Aurora Hospital, Eye and Ear Hospital, Peijas Hospital and Jorvi Hospital, with some services provided at Espoo, Haartman, Herttoniemi, Laakso and Malmi city hospitals. There are four other hospital areas in the district: Hyvinkää (Hyvinkää and Kellokoski Hospitals), Lohja (Lohja Hospital), Länsi-Uusimaa (Raasepori Hospital) and Porvoo (Porvoo Hospital)[186].

At the time of this study, in addition to the Helsinki University Hospital's Ear Clinic, ear, nose and throat day surgery was also performed in Hyvinkää, Porvoo, Lohja and Raasepori Hospitals. In addition to the orthopedic and hand day surgery unit of Helsinki University Hospital at Herttoniemi Hospital, day surgery was also performed in Jorvi, Peijas, Hyvinkää and Porvoo Hospitals.

4.2 THE STUDY POPULATION

During 2000-2013, 28,591,840 secondary and tertiary care visits occurred in the public hospitals of the hospital district. In order to retrospectively collect the weekend effect study population (Studies I and II), patients with missing data in key fields, outpatients, day surgery patients and patients admitted and discharged on the same day were excluded (Figure 3).

Study I comprised inpatients treated solely in Helsinki University Hospital or both in the university hospital and a secondary hospital during the same episode of care. Study II comprised inpatients treated solely in secondary hospitals. Of the patients fitting these criteria, the outcomes of those, who died during their hospital stay or within 30 days of discharge, were studied.

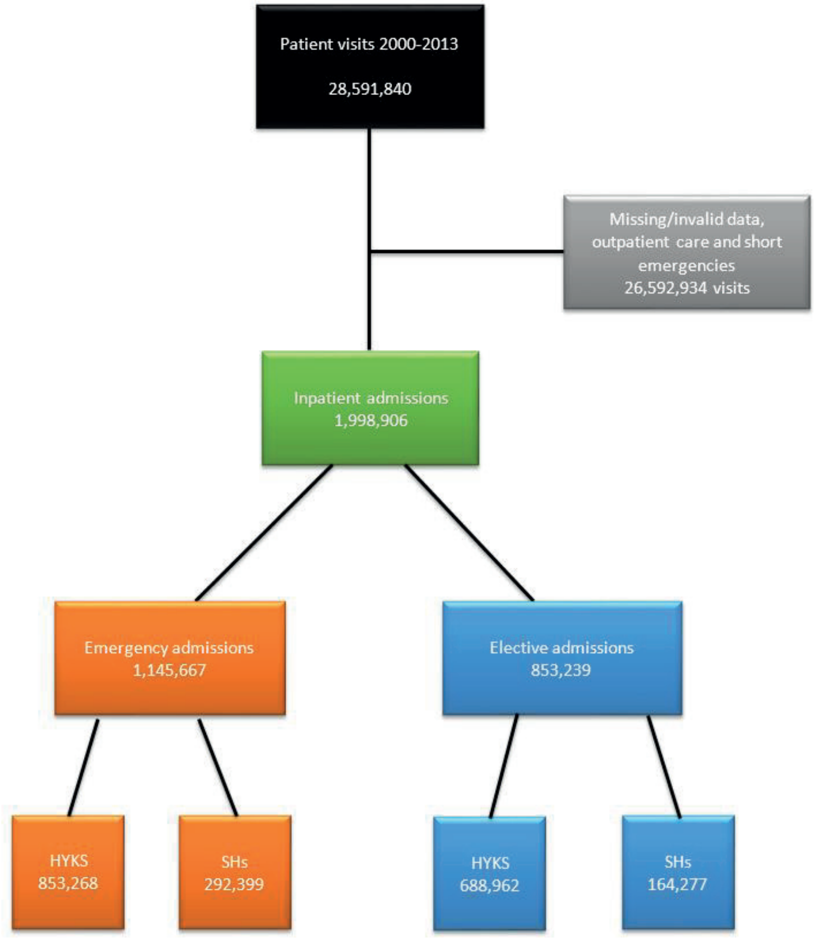


Figure 3 Study population for weekend effect study. HYKS = Helsinki University Hospital, SHs = secondary hospitals.

In Studies III and IV, patients having undergone ear, nose and throat, orthopedic or hand day surgery procedures between January 1, 2015 and March 31, 2015 at the Eye and Ear Hospital (ENT) or Herttoniemi Hospital (OHS) were selected retrospectively using the surgery database of the hospital (GE Healthcare Centricity Opera OR Management Software) (Table 2 and 3) (search performed by Tolvi). Day surgery procedures were ranked by specialty according to their frequency and Nordic Medico-Statistical Committee (NOMESCO) Classification of Surgical Procedures[187], and combined if there was clinical overlapping in codes (Table 2 and 3). The 15 most common procedures were then chosen by clinicians from these specialties (Tolvi, Aaltonen and Paavola).

Tables 2 and 3 show the percentage of each procedure that was performed as day surgery in the clinic in question.

4.3 DATA SET

In Studies I and II, a database containing the following data was comprised in Ecomed Analyzer by DataWell data services (currently Prodacapo Finland Oy): weekday, month and year of admission, discharge and death; level of care (university or secondary hospital and transfers in between); urgency of admission (emergency or elective); most costly specialty at discharge; most costly main diagnosis at discharge; age and sex. In Study I, all other diagnoses were collected for six months prior to the care episode included in the study in order to calculate the Charlson comorbidity index (CCI).

In secondary hospitals (Study II), specialties numbered eight: acute psychiatry, surgery, gynecology and obstetrics, internal medicine, pulmonology, neurology, pediatrics and otorhinolaryngology. In addition to these specialties, Study I included four specialties that are centralized to the university hospital: anesthesiology, neurosurgery, oncology and geriatrics. Treatment of otorhinolaryngology patients is divided between the university hospital (elective and emergency patients) and the secondary hospitals (elective patients). The specialty of anesthesiology comprises patients in the ICU at the time of their death or discharge.

Death during hospital stay (in-hospital mortality) and all-cause mortality within 30 days of discharge (30-day post-discharge mortality) were chosen as outcomes. The day of the week of admission was examined in order to identify whether a weekend effect or end-of-week effect existed. The weekend is defined in this study as beginning midnight Saturday morning and ending midnight Sunday night, and an end-of-week effect as patients admitted on Friday, Saturday, Sunday or Monday having higher mortality. Only seven to ten public holidays per year occurred during the week. Therefore, due to this small number, these holidays were not included as weekends. Mohammed et al. used the same approach previously[54]. Risk category was calculated by dividing the patients in these studies according to the crude mortality rate for each main discharge diagnosis (International Classification of Diseases, ICD-10) into five equal groups[146].

Procedure code	Procedure name	No. of day surgery patients	Overall day surgery percentage in unit	No. (%) of female patients
EMB10	Tonsillectomy	168	92.3	97 (57.7)
DCA20	Tube insertion	152	100	57 (37.5)
DMB20†	Maxillary antrostomy	129	87.8	76 (58.9)
EMB30	Adenoidectomy	128	100	45 (35.2)
EMB15	Tonsillotomy	78	97.5	31 (39.7)
DJD20§	Septoplasty	36	87.8	12 (33.3)
DHD10	Closed reduction of nasal fracture	35	100	11 (31.4)
DQB10‡	Excision of lesion of larynx	33	82.5	12 (36.4)
DDA00	Stapedotomy	31	93.9	20 (64.5)
DCD00	Myringoplasty	30	100	22 (73.3)
PJD41	Excision of cervical lymph node	27	81.8	10 (37.0)
UEL02	Sialendoscopy	27	100	16 (59.3)
EMB20	Adenotonsillectomy	26	86.7	12 (46.2)
QAE10	Excision of skin lesion from head or neck	24	100	12 (50.0)
DCD10	Tympanoplasty	23	92	12 (52.2)
DHB20†	Polypectomy	21	95.5	10 (47.6)
DNB20†	Ethmoidectomy	21	91.3	8 (38.1)
DLD00§	Septocolumelloplasty	14	58.3	2 (14.3)
DQA10‡	Biopsy of larynx	8	61.5	3 (37.5)
Total		1011		468 (46.3)

Table 2. ENT day surgery procedures and characteristics of study population in 2015 included in Study III. † combined to form endoscopic sinus surgery group. ‡ combined to form excision of lesion of larynx group. Modified with permission from Tolvi et al. Overstay and Readmission in Ear, Nose and Throat Day Surgery – Factors Affecting Postanesthesia Course. Ear, Nose Throat J. 2019; 145561319872165.

Procedure code	Procedure name	No. of day surgery patients	Overall day surgery percentage in unit	No. (%) of female patients
ACC51	Decompression of median nerve	167	96.5	124 (74.3)
NDM40	Discission of sheath of tendon of wrist or hand	46	97.9	29 (63.0)
ACC53	Decompression of ulnar nerve	43	97.7	22 (51.2)
NDM10	Palmar fasciotomy of hand	42	100	8 (19.0)
NDR20¶	Incomplete excision of soft tissue tumor of wrist or hand	36	92.3	17 (47.2)
NDG60	Arthroplasty of first CMC joint	34	89.5	29 (85.3)
NDM20	Excision of synovial ganglion of wrist or hand	25	100	19 (76.0)
NDG76	Fusion of DIP joint	23	95.8	17 (73.9)
NDF25	Open operation for osteochondritis of joint of wrist	22	95.7	11 (50.0)
NDA30	Arthroscopic exploration of joint of wrist or hand	18	81.8	14 (77.8)
NDR30¶	Radical excision of soft tissue tumor of wrist or hand	17	89.5	8 (47.1)
NDG20	Partial fusion of wrist	16	94.1	5 (31.3)
NGD05	Arthroscopic partial excision of meniscus of knee	16	88.9	7 (43.8)
NDU20	Removal of internal fixation device from wrist or hand	14	93.3	9 (64.3)
NBU20	Removal of internal fixation device from shoulder or upper arm	12	85.7	1 (8.3)
NDE40	Plastic repair of ligament or capsule of wrist with transplant	11	100	5 (45.5)
Total		542		325 (60.0)

Table 3. OHS day surgery procedures and characteristics of study population in 2015 included in Study IV. ¶ combined to form excision of soft tissue tumor of wrist or hand group. CMC = carpometacarpal, DIP = distal interphalangeal. Modified with permission from Tolvi et al. Root causes of extended length of stay and unplanned readmissions after orthopedic surgery and hand surgery: a retrospective observational cohort study. Patient Saf Surg. 2020;14:27.

Pre-, intra- and postoperative data on day surgery patients were collected from electronic patient files (Tolvi). These data comprised the following variables: age, sex, ASA class, date of operation, day of the week, type of anesthesia and surgeon. For orthopedic and hand surgery patients, anesthesia records were also reviewed (Tolvi and Tuominen-Salo). These anesthesia record data comprised the following variables: weight, height, pre-existing medical conditions, anticoagulant use, immunosuppression, smoking status, premedication, intraoperative and postoperative pain medication, anesthesia drugs, prophylactic antibiotics, perioperative antiemetics, use of laryngeal mask airway or intubation, numeric rating scale (NRS) for pain in the recovery room and blood pressure. Using weight and height, body mass index (BMI) was calculated using the following equation:

$$BMI = weight\ (kg)/(height\ (m))^2$$

In addition, information was collected pertaining to all recorded events (phone calls, emergency room visits, ward admissions) within 30 days of surgery (Tolvi). Procedures were grouped according to their similarities: for ENT, namely ear surgery, nasal surgery, tonsil and adenoid surgery, and miscellaneous; for OHS, namely shoulder and elbow surgery, hand surgery and lower limb surgery. For all procedures, the form of anesthesia, the operation, the premedication and the treatment of pain, nausea and vomiting were implemented following the protocol of the day surgery unit. Local or regional anesthesia was favored when medically possible but general anesthesia was also available upon request for e.g. anxious patients. Owing to the nature of some operations, for example tonsil surgery, general anesthesia was used for every patient. In Study IV, prophylactic antibiotics were administered if the patient had a medical condition predisposing them to a higher infection risk or if an implant was used. Primarily, intravenous cefuroxime 1.5g was given but secondarily, in the case of allergy, intravenous clindamycin 600mg. In the recovery room, NRS was used to evaluate pain and several values (0-10) were recorded.

When a patient is unable to be discharged after day surgery, they must be treated on the ward. This event is referred to as an overstay in this study. If a problem in recuperation should occur after discharge, patients may contact the hospital either by phone or by visiting the emergency department. These occasions are referred to as contacts in this research. Only phone calls pertaining to the study procedure were included in Studies III and IV. Treatment in the emergency department of the clinic is usually sufficient for problems after day surgery. However, if a patient is admitted to the ward in conjunction with one of these contacts, a readmission occurs. In both Studies III and IV, only patients rated ASA class I to IV were eligible for day surgery.

Patients were evaluated during their preoperative outpatient clinic visit in regard to their eligibility for day surgery. Only patients conforming to the criteria of the clinic were scheduled for day surgery. A total of 1,011 ENT patients and 542 OHS patients were included in this study. Orthopedic and hand surgery patients below the age of 16 years old were not included in this study as these procedures are performed at the Helsinki University Children's Hospital.

4.4 STATISTICAL ANALYSIS

In studies I and II, the effect of confounding variables (age, sex, risk category, weekday, year and month, (and in Study I CCI)) on the weekend effect was analyzed using multivariable logistic regression and adjusted odds ratio (OR) with 95% confidence intervals (CI) were calculated using R language (R Core Team. R: A Language and Environment for Statistical Computing, Vienna, Austria: R Foundation for Statistical Computing 2019). P-values less than 0.05 were regarded as statistically significant. The calculation of risk category was performed to correct for lack of information on disease severity.

In Study I, CCI was calculated using all diagnoses from the six months prior to the care episode in question and CCI was included in multivariable logistic regression as well[188,189].

In study III, the association between day surgery outcomes and confounding variables age, sex, ASA class, form of anesthesia and type of procedure were analyzed using univariable and multivariable logistic regression, and unadjusted and adjusted OR with 95% CI were calculated using IBM SPSS Statistics 22.0 (IBM Corp., Armonk, NY, USA). P-values less than 0.05 were regarded as statistically significant. Overstay, readmission and contacts were studied as outcomes of day surgery.

Using Pearson chi-square test or Fischer's exact test, study IV examined the effect of sex, age, ASA class, type of procedure, form of anesthesia, use of laryngeal mask airway versus intubation, pre-, intra- and postoperative use of various anesthesia drugs and analgesics, underlying medical conditions and medications, pain rating on the NRS in the recovery room, BMI, smoking status and intraoperative hypotension (systemic blood pressure <100mmHg) or hypertension (systolic blood pressure >140mmHg) on the risk of overstay, readmission or contact.

Factors, which rose to statistical significance, were included in the multivariable model and joined in various combinations to find risk profiles for outcomes. Using contingency tables, negative predictive value (NPV), positive predictive value (PPV), specificity and sensitivity were calculated for risk factor combinations. Adjusted ORs with 95% CI were calculated for these combinations with logistic regression. P-values less than 0.05 were regarded as statistically significant. ORs were used as outcomes were rare and so close to relative risk. The data were analyzed using IBM SPSS Statistics 25.0 (IBM. Corp., Armonk, NY).

4.5 ETHICAL CONSIDERATIONS

All four component articles were retrospective registry studies without patient interventions. The Research Administration of the Helsinki and Uusimaa Hospital District approved all studies upon review of the research plan (Y1014KORV1). No ethics committee approval was required by Finnish national legislation in accordance with The Medical Research Act of Finland 488/1999[190].

In Studies I and II, the database was constructed by Prodacapo Finland Oy (formerly DataWell at the time of database construction) on a secure server with electronical data protection tools and restricted access to data. Patients were given identification codes and the identity of patients was not known to the researchers involved. In Studies III and IV, during patient and data collection the data was anonymized. In all four component articles, statisticians received only anonymous data with no identifying personalizing details. In order to guarantee the reproducibility of the research, fully anonymized data has been stored, in compliance with the Medical Research Act of Finland 488/1999 and General Data Protection Regulation (GDPR), electronically with restricted access and data protection[190,191].

5 RESULTS

5.1 WEEKEND EFFECT IN HELSINKI UNIVERSITY HOSPITAL

In Study I, of the 1,542,230 inpatients treated at Helsinki University Hospital between 2000 and 2013, 853,268 were emergency patients (Tables 4 and 5). The deaths of 47,122 occurred in hospital or within 30 days of discharge. Emergency patients were involved in 79.5% (n=37,470) of these deaths. The overall crude mortality rate numbered 3.1%, crude emergency mortality rate 4.4% and crude elective mortality rate 1.4%, respectively. As could be expected, the age group of 70 years and older had the most deaths for the majority of specialties. However, acute psychiatry (ages 20-39), oncology (ages 60-69) and pediatrics (ages 0-1) were exceptions. Otorhinolaryngology is found in the centralized specialties for emergency patients as emergency treatment is centralized to the university hospital, but elective patients are also treated in secondary hospitals.

	Surgery	Gynecology & Obstetrics	Neurosurgery	Otorhinolaryngology
Total Patients (% Male)	456305 (51.4)	293536 (0)	39774 (51.7)	47126 (53.2)
Total Deaths (% Male Deaths)	9298 (55.2)	845 (0)	1948 (60.4)	255 (65.1)
Crude Mortality Rate of Specialty % (% Male)	2.0 (2.2)	0.3 (0)	4.9 (5.7)	0.5 (0.7)
Deaths in Age Group n (%)				
<20 Years Old (% of All Deaths)	97 (1.0)	1 (0.1)	32 (1.6)	4 (1.6)
20-39 (%)	176 (1.9)	36 (4.3)	147 (7.5)	6 (2.4)
40-49 (%)	344 (3.7)	61 (7.2)	236 (12.1)	15 (5.9)
50-59 (%)	955 (10.3)	166 (19.6)	390 (20.0)	44 (17.3)
60-69 (%)	1564 (16.8)	241 (28.5)	438 (22.5)	66 (25.9)
70+ (%)	6162 (66.3)	340 (40.2)	705 (36.2)	120 (47.1)
Emergency Deaths (%)	6912 (74.3)	611 (72.3)	1566 (80.4)	162 (63.5)

Table 4. Patient characteristics of 836,741 inpatients in surgical specialties in Helsinki University Hospital between 2000 and 2013. Deaths include both in-hospital deaths and deaths within 30 days of discharge. Modified with permission from Tolvi et al. Analysis of weekend effect on mortality by medical specialty in Helsinki University Hospital over a 14-year period. Health Policy. 2020;S0168-8510(20)30192-5.

	Acute Psychiatry	Internal Medicine	Pulmonology	Neurology	Anesthesiology	Oncology	Geriatrics		Pediatrics
Total Patients (% Male)	41286 (43.9)	394866 (51.1)	60056 (56.3)	77204 (53.0)	1345 (68.0)	41876 (49.4)	7920 (45.8)		80936 (55.0)
Total Deaths (% Male Deaths)	167 (58.7)	20659 (51.8)	4855 (61.8)	2931 (50.2)	544 (80.7)	4446 (50.3)	719 (51.2)		455 (54.5)
Crude Mortality Rate of Specialty (% Male)	0.4 (0.5)	5.2 (5.3)	8.1 (8.9)	3.8 (3.6)	40.5 (40.2)	10.6 (10.8)	9.1 (10.1)		0.6 (0.6)
Deaths in Age Group n (%)									
<20 Years Old (% of All Deaths)	3 (1.8)	134 (0.6)	10 (0.21)	20 (0.7)	7 (1.3)	98 (2.2)	0 (0)	**0-1 years old**	312 (68.6)
20-39 (%)	66 (39.5)	413 (2.0)	59 (1.2)	58 (2.0)	29 (5.3)	214 (4.8)	31 (4.3)	**1-2**	17 (3.7)
40-49 (%)	37 (22.2)	885 (4.3)	138 (2.8)	115 (3.9)	50 (9.2)	403 (9.1)	34 (4.7)	**2-5**	38 (8.4)
50-59 (%)	29 (17.4)	2277 (11.0)	743 (15.3)	329 (11.2)	93 (17.1)	1034 (23.3)	97 (13.5)	**5-10**	28 (6.2)
60-69 (%)	19 (11.4)	3745 (18.1)	1256 (25.9)	596 (20.3)	125 (23.0)	1410 (31.7)	177 (24.6)	**10-15**	41 (9.0)
70+ (%)	13 (7.8)	13205 (63.9)	2649 (54.6)	1813 (61.9)	240 (44.1)	1287 (28.9)	380 (52.9)	**15-20**	16 (3.5)
								>20	3 (0.7)
Emergency Deaths (%)	132 (79.0)	17473 (84.6)	3998 (82.3)	2643 (90.2)	276 (50.7)	2746 (61.8)	596 (82.9)		355 (78.0)

Table 5. Patient characteristics of 705,489 inpatients in conservative specialties in Helsinki University Hospital between 2000 and 2013. Deaths include both in-hospital deaths and deaths within 30 days of discharge. Modified with permission from Tolvi et al. Analysis of weekend effect on mortality by medical specialty in Helsinki University Hospital over a 14-year period. Health Policy.2020;S0168-8510(20)30192-5.

5.1.1 MORTALITY BY SPECIALTY

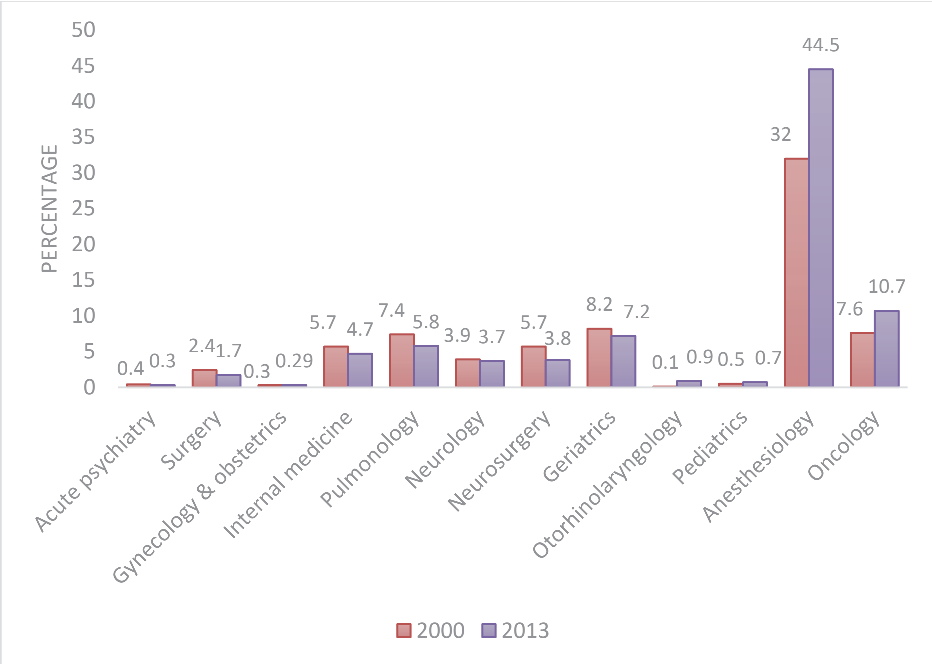


Figure 4 The annual crude mortality rate (%) for the year 2000 and 2013 by specialty in the Helsinki University Hospital.

5.1.2 MORTALITY BY YEAR

The odds of mortality were highest in the year 2001. A steady decrease in the risk of mortality began in 2008 and declined unwaveringly all the way to 2013 (Figure 5). In comparison with 2007, significantly lower mortality was observed in 2008-2013 and higher only in 2001. These ORs were calculated from separate models from different years. The highest risk of mortality during the weekend was in 2002 (Figure 6). In comparison with weekday mortality, significantly higher mortality was seen during the weekend in 2000-2002 and significantly lower in 2013.

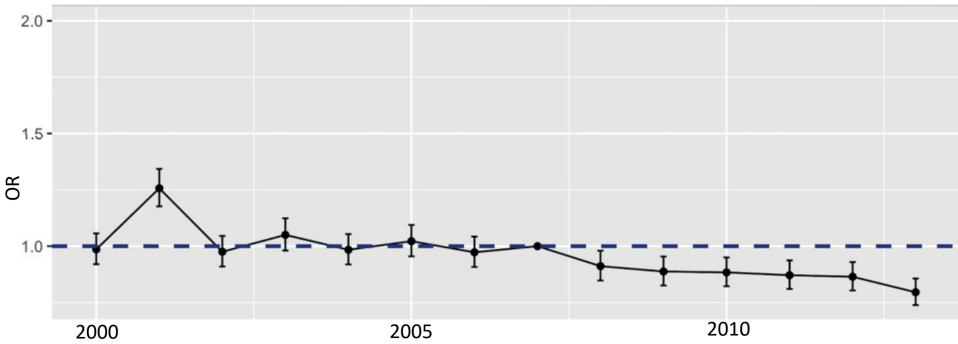


Figure 5 The overall adjusted odds ratio (OR) by year from 2000 to 2013 for all mortality for all inpatients in Helsinki University Hospital. The reference year (OR=1) is 2007. Reproduced with permission from Tolvi et al. Analysis of weekend effect on mortality by medical specialty in Helsinki University Hospital over a 14-year period. *Health Policy*. 2020;S0168-8510(20)30192-5.

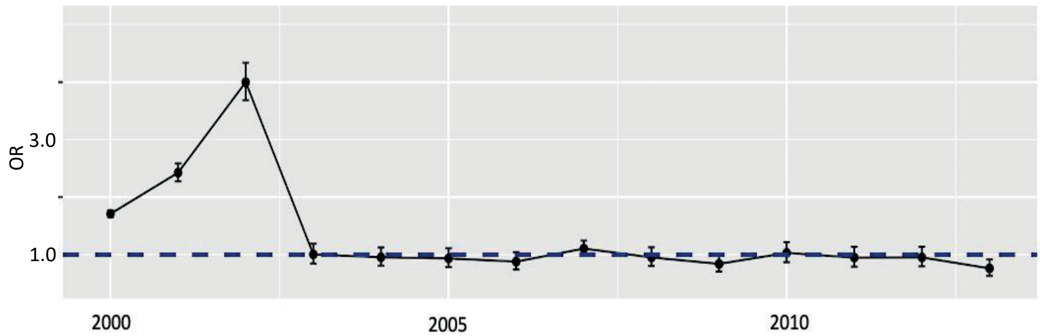


Figure 6 The overall adjusted odds ratio (OR) for weekday admissions (OR=1) versus weekend admissions by year from 2000 to 2013 for all mortality for all inpatients in Helsinki University Hospital. Reproduced with permission from Tolvi et al. Analysis of weekend effect on mortality by medical specialty in Helsinki University Hospital over a 14-year period. *Health Policy*. 2020;S0168-8510(20)30192-5.

5.1.3 MORTALITY BY SEX

Of 12 specialties, 11 had both female and male patients. In in-hospital mortality, females had a significantly lower risk of death in internal medicine (adjusted OR 0.85, 95% CI 0.82-0.89), acute psychiatry (0.58, 0.37-0.93), surgery (0.78, 0.73-0.83), pulmonology (0.84, 0.79-0.91), neurosurgery (0.82, 0.73-0.93) and geriatrics (0.78, 0.64-0.95). For 30-day post-discharge mortality, females had a lower risk in the specialties of neurosurgery (0.67, 0.57-0.79), internal medicine (0.91, 0.87-0.95), surgery (0.86, 0.81-0.91), acute psychiatry (0.39, 0.29-0.53) and pulmonology (0.77, 0.72-0.83).

5.1.4 WEEKEND ADMISSIONS

Overall, 16.7% (n=258,017) of patients were admitted at the weekend, i.e. Saturday or Sunday. Figure 7 shows the percentage of weekend versus weekday admissions by specialty.

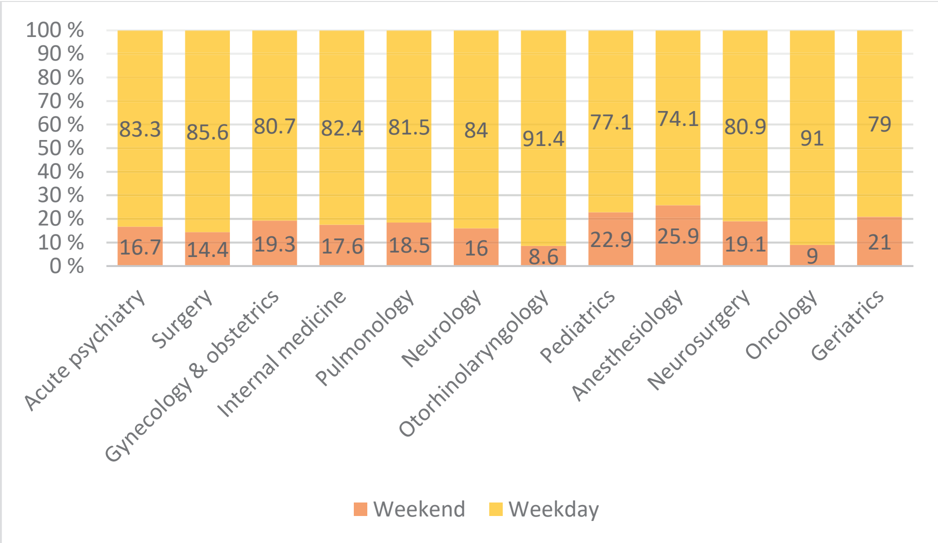


Figure 7 Percentage of patients admitted during the weekend versus during the week by specialty during 2000-2013 in Helsinki University Hospital.

5.1.5 EMERGENCY ADMISSIONS

Odds ratios of in-hospital mortality were lower in most specialties for emergency admissions on weekdays compared with weekend emergency admissions when adjusting for age, sex, risk category, CCI, weekday, year and month (Figure 8). Odds ratio of 30-day post-discharge mortality was only statistically significant for internal medicine for emergency admissions on weekdays compared with weekend emergency admissions when adjusting for age, sex, risk category, CCI, weekday, year and month (Figure 9).

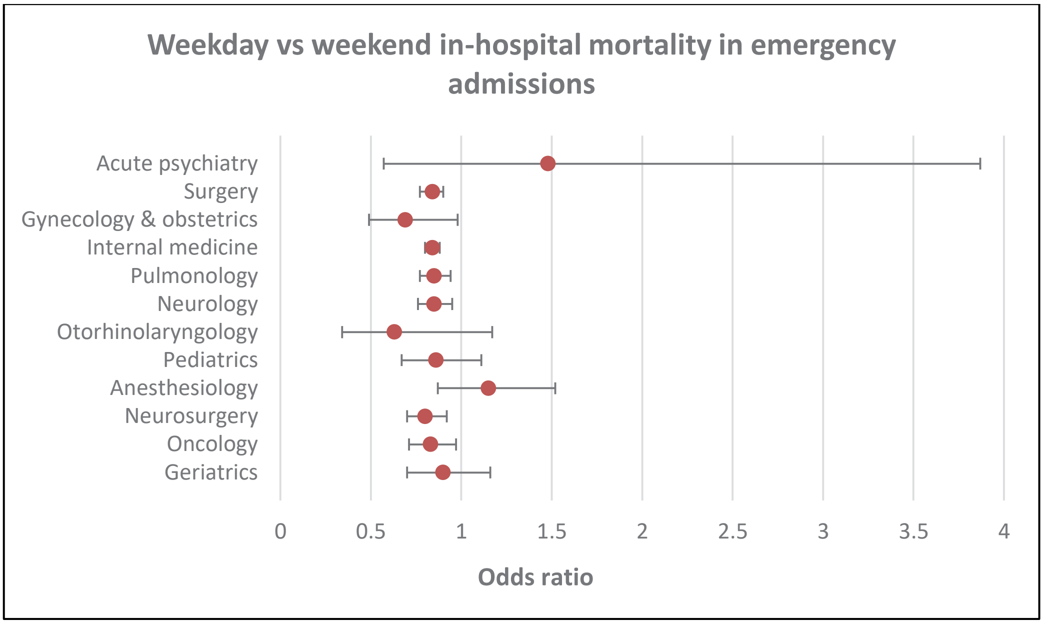


Figure 8 Adjusted odds of in-hospital mortality in 853,268 emergency admissions by specialty in Helsinki University Hospital. Weekend mortality OR=1.

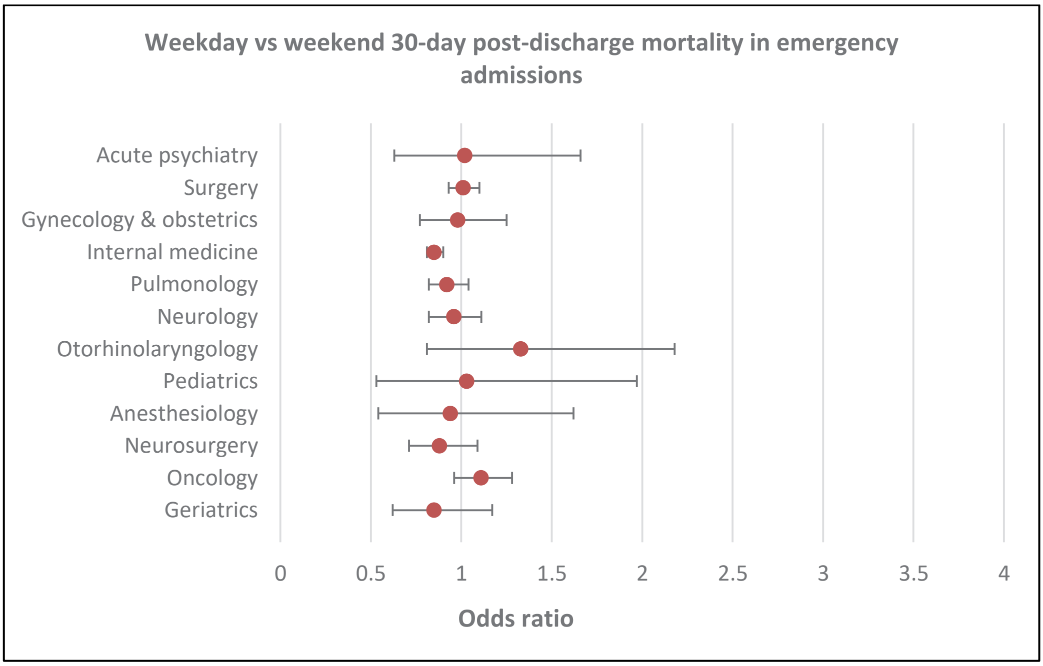


Figure 9 Adjusted odds of 30-day post-discharge mortality in 853,268 emergency admissions by specialty in Helsinki University Hospital. Weekend mortality OR=1.

5.1.6 ELECTIVE ADMISSIONS

Odds ratios of in-hospital mortality were lower in most specialties for elective admissions on weekdays compared with weekend elective admissions when adjusting for age, sex, risk category, CCI, weekday, year and month (Figure 10).

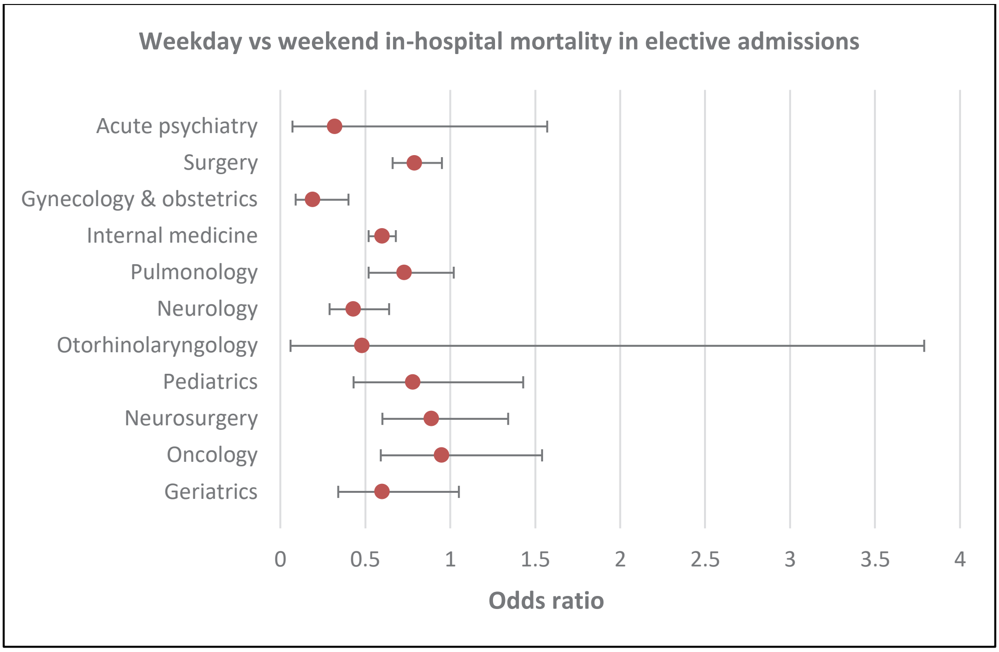


Figure 10 Adjusted odds of in-hospital mortality in 688,962 elective admissions by specialty in Helsinki University Hospital. Weekend mortality OR=1. The amount of elective anesthesia patients was insufficient to calculate OR.

Odds ratios of 30-day post-discharge mortality were only statistically significant for gynecology and obstetrics and neurology for elective admissions on weekdays compared with weekend elective admissions when adjusting for age, sex, risk category, CCI, weekday, year and month (Figure 11).

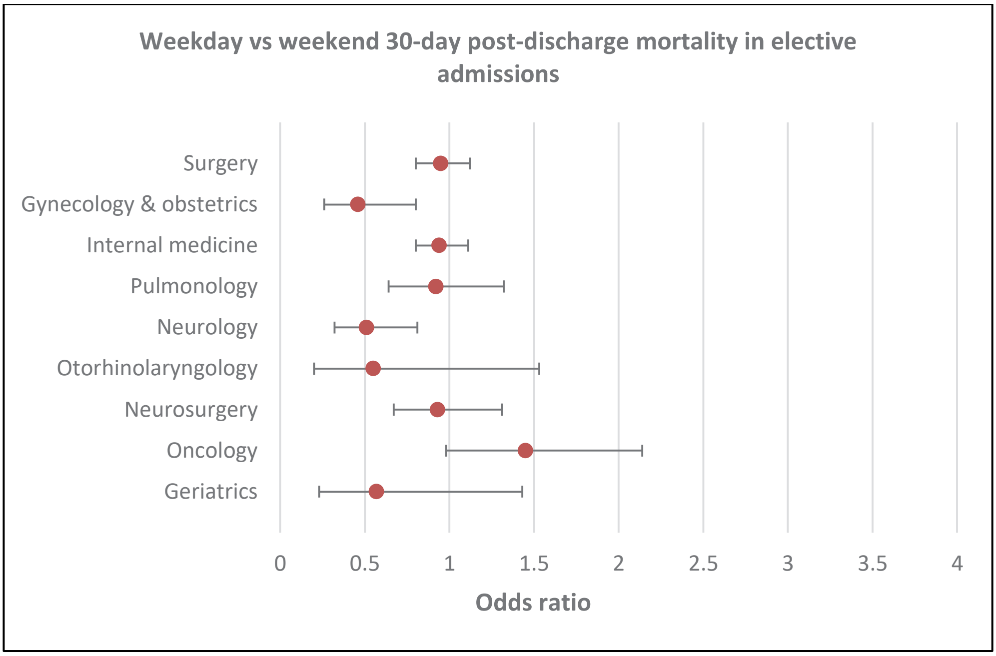


Figure 11 Adjusted odds of 30-day post-discharge mortality in 688,962 elective admissions by specialty in Helsinki University Hospital. Weekend mortality OR=1. The amount of elective anesthesia patients was insufficient to calculate OR. In the specialties of acute psychiatry and pediatrics, confidence interval was 0-Inf and thus, could not be visualized in the same graph. Acute psychiatry OR $4.08*10^7$, pediatrics OR 1.55*10

5.1.7 MORTALITY BY YEAR AND SPECIALTY

The specialties most sensitive to the weekend effect in the university hospital were surgery, internal medicine, neurology, and gynecology and obstetrics. Odds of mortality were adjusted for age, sex, risk category, CCI, weekday, year and month. Tables 6 and 7 show the years with a statistically significant risk: lower risk than 2010 highlighted in green, higher risk in yellow.

	Surgery				Internal medicine			
	elective		emergency		elective		emergency	
year	in-hospital	30-day	in-hospital	30-day	in-hospital	30-day	in-hospital	30-day
2000	1.74 (1.28-2.37)	1.52 (1.13-2.03)	1.64 (1.37-1.96)	1.15 (0.96-1.38)	1.64 (1.24-2.17)	1.31 (1.01-1.70)	1.21 (1.10-1.35)	1.10 (0.97-1.26)
2001	1.32 (0.95-1.84)	1.87(1.40-2.50)	1.25 (1.04-1.50)	1.40 (1.18-1.67)	1.29 (0.94-1.75)	1.57 (1.21-2.04)	0.88 (0.79-0.98)	1.59 (1.41-1.80)
2002	1.29 (0.93-1.79)	1.54 (1.15-2.06)	1.52 (1.27-1.82)	1.26 (1.05-1.50)	1.52 (1.13-2.05)	0.82 (0.60-1.11)	1.06 (0.96-1.18)	1.08 (0.95-1.24)
2003	1.23 (0.88-1.71)	1.62 (1.21-2.17)	1.36 (1.14-1.63)	1.26 (1.05-1.50)	1.55 (1.16-2.08)	1.08 (0.81-1.43)	0.95 (0.85-1.05)	1.11(0.98-1.27)
2004	0.93 (0.66-1.33)	1.26 (0.92-1.71)	1.26 (1.05-1.52)	1.15 (0.96-1.38)	1.52 (1.13-2.04)	0.84 (0.62-1.14)	0.93 (0.84-1-03)	1.19 (1.05-1.35)
2005	1.62 (1.19-2.20)	1.24 (0.92-1.68)	1.15 (0.95-1.40)	1.10 (0.91-1.34)	1.93 (1.48-2.51)	1.36 (1.07-1.75)	0.91 (0.82-1.01)	1.11 (0.97-1.26)
2006	1.03 (0.73-1.45)	1.23 (0.91-1.68)	1.11 (0.91-1.35)	0.96 (0.78-1.17)	2.33 (1.81-3.01)	1.27 (0.99-1.62)	0.90 (0.81-1.00)	1.06 (0.93-1.21)
2007	0.95 (0.67-1.36)	1.14 (0.82-1.57)	0.78 (0.62-0.97)	0.95 (0.77-1.17)	2.04 (1.57-2.65)	1.19 (0.92-1.52)	0.81 (0.73-0.90)	1.16 (1.02-1.31)
2008	1.03 (0.73-1.46)	1.09 (0.79-1.50)	0.87 (0.70-1.09)	0.86 (0.69-1.07)	1.62 (1.23-2.14)	0.72 (0.54-0.97)	0.75 (0.66-0.84)	0.96 (0.83-1.11)
2009	0.92 (0.64-1.31)	1.10 (0.80-1.53)	1.23 (1.01-1.50)	0.88 (0.72-1.08)	1.00 (0.73-1.36)	0.75 (0.56-1.00)	1.00 (0.90-1.12)	1.07 (0.93-1.22)
2010	1	1	1	1	1	1	1	1
2011	0.71(0.49-1.03)	1.20 (0.88-1.64)	0.97 (0.79-1.20)	0.92 (0.75-1.14)	1.13 (0.83-1.54)	0.88 (0.67-1.18)	0.93 (0.83-1.03)	1.09 (0.95-1.24)
2012	0.77 (0.53-1.11)	0.76 (0.54-1.08)	1.01 (0.82-1.24)	0.78 (0.63-0.97)	0.91 (0.66-1.26)	0.73 (0.54-0.99)	0.94 (0.85-1.05)	1.03 (0.90-1.17)
2013	0.69(0.47-1.00)	0.97 (0.70-1.33)	0.86 (0.70-1.06)	0.73 (0.59-0.90)	0.85 (0.62-1.18)	0.59 (0.43-0.81)	0.89 (0.79-0.99)	1.05 (0.92-1.19)

Table 6. Adjusted odds of in-hospital and 30-day post-discharge mortality in emergency and elective admissions by specialty and year in Helsinki University Hospital for the specialties of surgery and internal medicine. Reference year is 2010 (OR=1). Statistically significant ORs are highlighted: green lower risk, yellow higher risk.

	Neurology				Gynecology & obstetrics			
	elective		emergency		elective		emergency	
year	**in-hospital**	**30-day**	**in-hospital**	**30-day**	**in-hospital**	**30-day**	**in-hospital**	**30-day**
2000	0.47 (0.20-1.09)	0.50 (0.19-1.32)	1.24 (0.97-1.58)	1.48 (1.06-2.08)	2.55 (0.55-11.88)	0.56 (0.26-1.23)	1.92 (0.85-4.33)	1.00 (0.57-1.74)
2001	0.27 (0.09-0.76)	0.43 (0.15-1.24)	1.10 (0.85-1.42)	1.58 (1.13-2.21)	1.19 (0.21-6.68)	0.59 (0.27-1.30)	1.70 (0.74-3.92)	1.30 (0.76-2.21)
2002	0.59 (0.25-1.39)	0.86 (0.34-2.18)	1.52 (1.19-1.94)	1.52 (1.07-2.15)	1.12 (0.18-6.95)	0.36 (0.14-0.93)	1.55 (0.65-3.68)	0.79 (0.43-1.45)
2003	0.32 (0.11-0.92)	0.34 (0.10-1.13)	1.09 (0.84-1.41)	1.54 (1.10-2.16)	2.50 (0.44-14.19)	1.14 (0.51-2.55)	1.85 (0.82-4.14)	0.81 (0.46-1.44)
2004	0.46 (0.18-1.19)	0.85 (0.33-2.21)	1.07 (0.83-1.38)	0.98 (0.68-1.41)	1.15 (0.16-8.40)	1.38 (0.64-2.99)	0.90 (0.36-2.27)	1.10 (0.65-1.87)
2005	0.94 (0.44-2.00)	1.06 (0.43-2.59)	0.94 (0.72-1.22)	1.14 (0.80-1.62)	3.02 (0.57-16.12)	0.96 (0.41-2.22)	1.45 (0.60-3.49)	1.67 (1.00-2.79)
2006	1.01 (0.50-2.06)	0.68 (0.27-1.72)	0.89 (0.68-1.17)	1.13 (0.79-1.62)	2.62 (0.46-14.83)	0.63 (0.24-1.63)	1.13 (0.48-2.66)	1.02 (0.60-1.72)
2007	0.85 (0.43-1.69)	0.79 (0.34-1.82)	0.90 (0.69-1.19)	1.16 (0.81-1.66)	0.56 (0.05-6.34)	0.91 (0.39-2.10)	1.03 (0.44-2.39)	0.76 (0.45-1.28)
2008	0.77 (0.38-1.57)	0.84 (0.36-1.96)	0.94 (0.72-1.23)	1.40 (0.99-1.97)	3.01 (0.57-16.03)	1.59 (0.75-3.38)	1.07 (0.45-2.57)	1.06 (0.63-1.77)
2009	0.14 (0.03-0.62)	0.43 (0.13-1.44)	0.85 (0.65-1.10)	1.30 (0.93-1.81)	3.66 (0.72-18.60)	0.75 (0.30-1.87)	1.17 (0.49-2.81)	0.91 (0.53-1.57)
2010	1	1	1	1	1	1	1	1
2011	0.53 (0.20-1.44)	0.83 (0.30-2.30)	0.85 (0.66-1.10)	0.97 (0.68-1.38)	2.73 (0.52-14.39)	1.20 (0.54-2.64)	1.24 (0.54-2.84)	1.23 (0.75-2.03)
2012	0.25 (0.07-0.89)	1.22 (0.48-3.11)	1.08 (0.84-1.38)	1.15 (0.81-1.62)	1.66 (0.27-10.15)	1.66 (0.79-3.49)	0.83 (0.32-2.13)	1.51 (0.92-2.49)
2013	0.25 (0.07-0.89)	0.76 (0.27-2.10)	0.79 (0.61-1.04)	1.06 (0.75-1.51)	1.02 (0.14-7.37)	0.96 (0.42-2.19)	1.22 (0.52-2.89)	1.00 (0.59-1.71)

Table 7. Adjusted odds of in-hospital and 30-day post-discharge mortality in emergency and elective admissions by specialty and year in Helsinki University Hospital for the specialties of neurology and gynecology & obstetrics. Reference year is 2010 (OR=1). Statistically significant ORs are highlighted: green lower risk, yellow higher risk.

5.1.8 PREVENTABLE DEATHS

By calculating the crude mortality rates for Saturday and Sunday admissions and comparing them to the crude mortality rate of Wednesday, we can estimate the number of preventable deaths potentially attributable to the weekend effect. In Helsinki University Hospital, these deaths numbered 3,701 (surgery n=725, internal medicine n=1,906, pediatrics n=16, oncology n=209, neurosurgery n=227, anesthesiology n=0, gynecology and obstetrics n=23, neurology n=385, acute psychiatry n=3, pulmonology n=140, otorhinolaryngology n=26, geriatrics n=41).

5.2 WEEKEND EFFECT IN SECONDARY HOSPITALS OF THE HOSPITAL DISTRICT

Of the 456,676 inpatients treated between 2000 and 2013 in the secondary hospitals of HUS, 292,399 were emergency patients (Tables 8 and 9). The deaths of 17,231 occurred in hospital or within 30 days of discharge. Emergency patients were involved in 86.9% (n=14,973) of these deaths. The overall crude mortality rate numbered 3.8%, crude emergency mortality rate 5.1% and crude elective mortality rate 1.4%, respectively. As could be expected, the age group of 70 years and older had the most deaths for the majority of specialties. However, acute psychiatry (ages 50-59) and pediatrics (ages 0-1) were exceptions.

	Surgery	Otorhinolaryngology	Gynecology & Obstetrics
Total patients (% Male)	151063 (51.7)	7664 (52.7)	79889 (0)
Total deaths (% Male Deaths)	4220 (52.0)	5 (60.0)	181 (0)
Crude mortality rate of specialty % (% Male)	2.8 (2.8)	0.1 (0.1)	0.2 (0)
Deaths in age group n (%)			
<20 years old (% of all deaths)	11 (0.3)	0 (0)	0 (0)
20-39 (%)	32 (0.8)	0 (0)	6 (3.3)
40-49 (%)	136 (3.2)	0 (0)	12 (6.6)
50-59 (%)	365 (8.6)	0 (0)	44 (24.3)
60-69 (%)	719 (17.0)	0 (0)	40 (22.1)
70+ (%)	2957 (70.1)	5 (100)	79 (43.6)
Emergency deaths (%)	3562 (84.4)	3 (60)	127 (70.2)

Table 8. Patient characteristics of 238,616 inpatients in surgical specialties at six secondary hospitals in HUS between 2000 and 2013. Deaths include both in-hospital deaths and deaths within 30 days of discharge. Modified with permission from Tolvi et al. Weekend effect on mortality by medical specialty in six secondary hospitals in the Helsinki metropolitan area over a 14-year period. BMC Health Serv Res.2020;20(1):323.

	Acute Psychiatry	Internal Medicine	Pulmonology	Neurology		Pediatrics
Total patients (% Male)	26664 (48.9)	126218 (47.7)	29228 (60.1)	12966 (47.0)		22984 (54.6)
Total deaths (% Male Deaths)	104 (77.9)	9591 (49.8)	2487 (65.2)	617 (46.5)		26 (46.2)
Crude mortality rate of specialty % (% Male)	0.4 (0.6)	7.6 (7.9)	8.5 (9.2)	4.8 (4.7)		0.1 (0.1)
Deaths in age group n (%)						
<20 years old (% of all deaths)	0	25 (0.3)	3 (0.1)	0 (0)	**0-1 years**	11 (42.3)
20-39 (%)	19 (18.3)	83 (0.9)	13 (0.5)	5 (0.8)	**1-2**	4 (15.4)
40-49 (%)	21 (20.2)	212 (2.2)	47 (1.9)	9 (1.5)	**2-5**	3 (11.5)
50-59 (%)	28 (26.9)	693 (7.2)	251 (10.1)	36 (5.8)	**5-10**	4 (15.4)
60-69 (%)	17 (16.3)	1294 (13.5)	650 (26.1)	91 (14.7)	**10-15**	3 (11.5)
70+ (%)	19 (18.3)	7284 (75.9)	1523 (61.2)	476 (77.1)	**15-20**	1 (3.8)
					>20	0 (0)
Emergency deaths (%)	81 (77.9)	8574 (89.4)	2070 (83.2)	539 (87.4)		17 (65.4)

Table 9. Patient characteristics of 218,060 inpatients in conservative specialties at six secondary hospitals in HUS between 2000 and 2013. Deaths include both in-hospital deaths and deaths within 30 days of discharge. Modified with permission from Tolvi et al. Weekend effect on mortality by medical specialty in six secondary hospitals in the Helsinki metropolitan area over a 14-year period. BMC Health Serv Res. 2020;20(1):323.

5.2.1 MORTALITY BY SPECIALTY

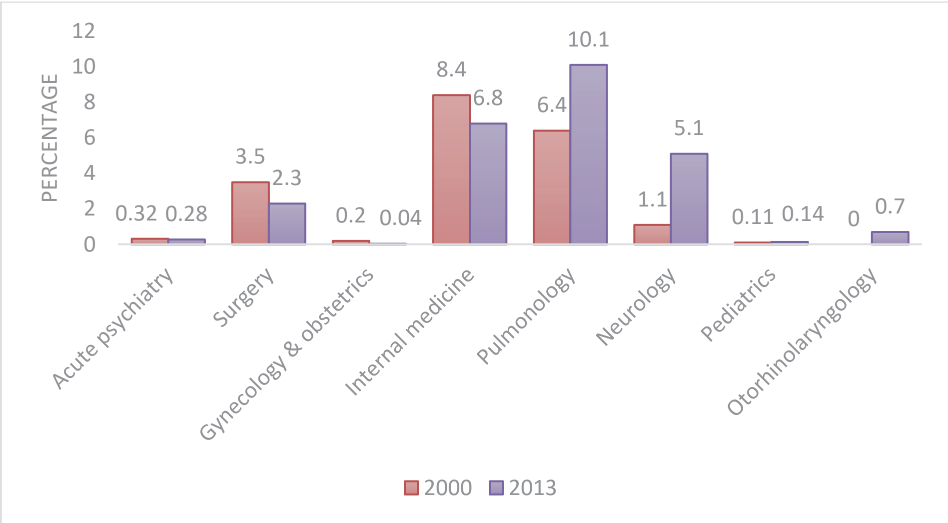


Figure 12 The annual crude mortality rate (%) for the year 2000 versus 2013 by specialty in the six secondary hospitals in the Helsinki and Uusimaa Hospital District.

5.2.2 MORTALITY BY YEAR

During 2004, the risk for mortality was at its lowest during the study period. From 2009 to 2013, the OR was fairly constant (Figure 13). During 2000-2001, 2007-2008 and 2011-2013, the risk of mortality was higher, and during 2002-2006 and 2010 lower during the weekend (Figure 14). However, none of these risks were statistically significant.

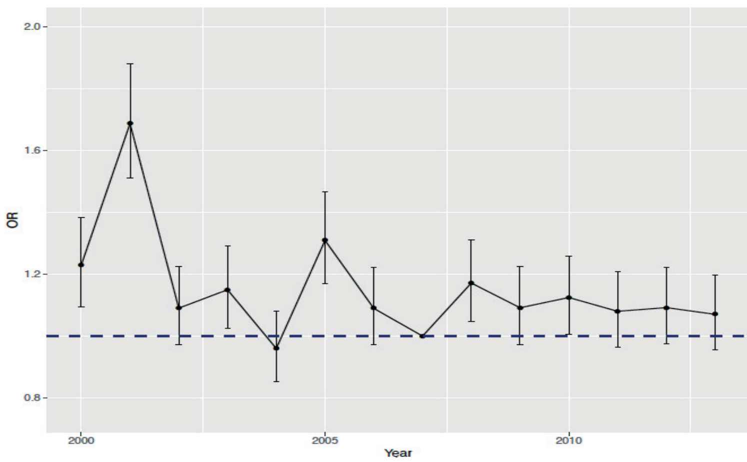


Figure 13 The overall adjusted odds ratio (OR) by year from 2000 to 2013 for all mortality for all inpatients in the six secondary hospitals in the Helsinki and Uusimaa Hospital District. The reference year (OR=1) is 2007. Reproduced with permission from *Tolvi et al. Weekend effect on mortality by medical specialty in six secondary hospitals in the Helsinki metropolitan area over a 14-year period. BMC Health Serv Res. 2020;20(1):323.*

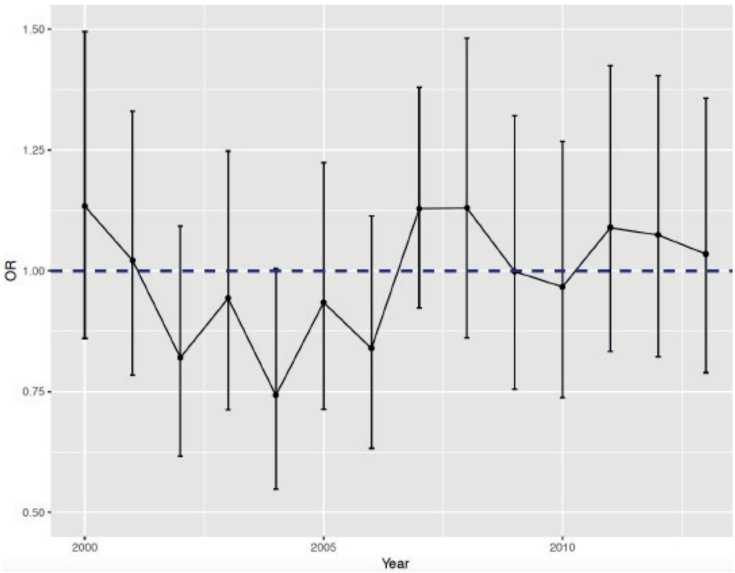


Figure 14 The overall adjusted odds ratio (OR) for weekday admissions (OR=1) versus weekend admissions by year from 2000 to 2013 for all mortality for all inpatients in the six secondary hospitals in the Helsinki and Uusimaa Hospital District. Reproduced with permission from *Tolvi et al. Weekend effect on mortality by medical specialty in six secondary hospitals in the Helsinki metropolitan area over a 14-year period. BMC Health Serv Res. 2020;20(1):323.*

5.2.3 MORTALITY BY SEX

Seven specialties had patients of both genders. For in-hospital mortality, females had a significantly lower risk for emergency acute psychiatry (adjusted OR 0.34, 95% CI 0.12-0.97), emergency surgery (0.80, 0.72-0.90), elective and emergency internal medicine (0.76, 0.62-0.91 and 0.75, 0.71-0.80). For 30-day post-discharge mortality, females had a lower risk for emergency and elective acute psychiatry (0.24, 0.13-0.46 and 0.06, 0.01-0.51), emergency surgery (0.84, 0.76-0.92), emergency internal medicine (0.91, 0.86-0.97) and emergency pulmonology (0.73, 0.64-0.84).

5.2.4 WEEKEND ADMISSIONS

Of admissions, 17.8% (n=81,277) took place on Saturday or Sunday. Figure 15 shows the distribution of admissions by specialty.

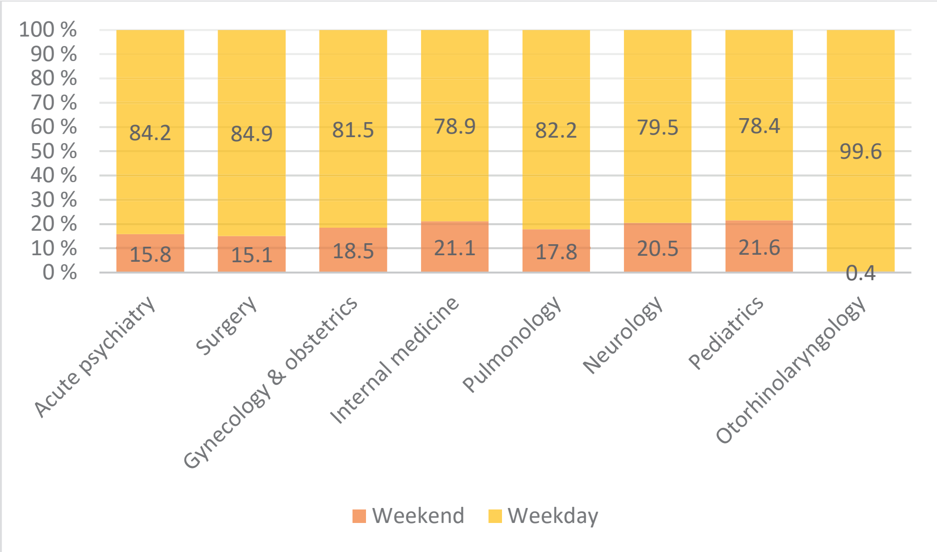
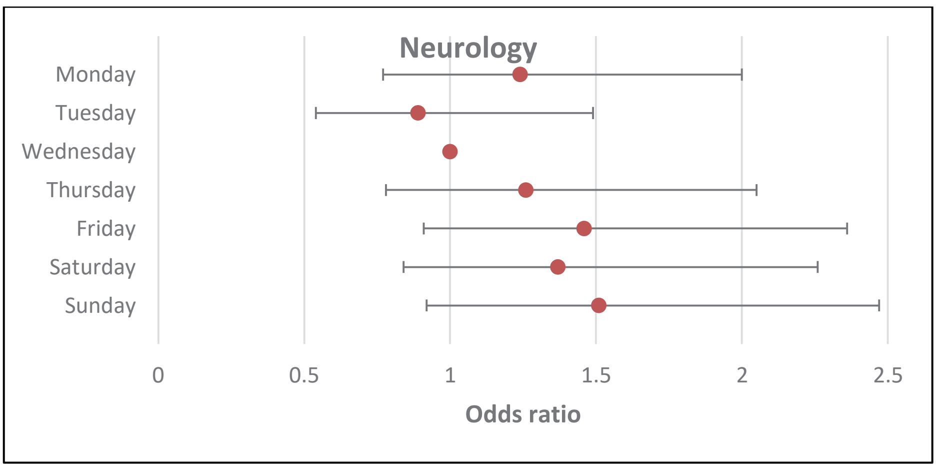


Figure 15 Percentage of patients admitted during the weekend versus during the week by specialty during 2000-2013 in the six secondary hospitals in the Helsinki and Uusimaa Hospital District.

5.2.5 EMERGENCY ADMISSIONS

Odds ratios of in-hospital mortality were lower in general for most specialties for emergency admissions on weekdays compared with weekend emergency admissions when adjusting for age, sex, risk category, weekday, year and month (Figure 16). Odds ratios of 30-day post-discharge mortality were lower in many specialties for emergency admissions on weekdays compared with weekend emergency admissions when adjusting for age, sex, risk category, weekday, year and month (Figure 17).



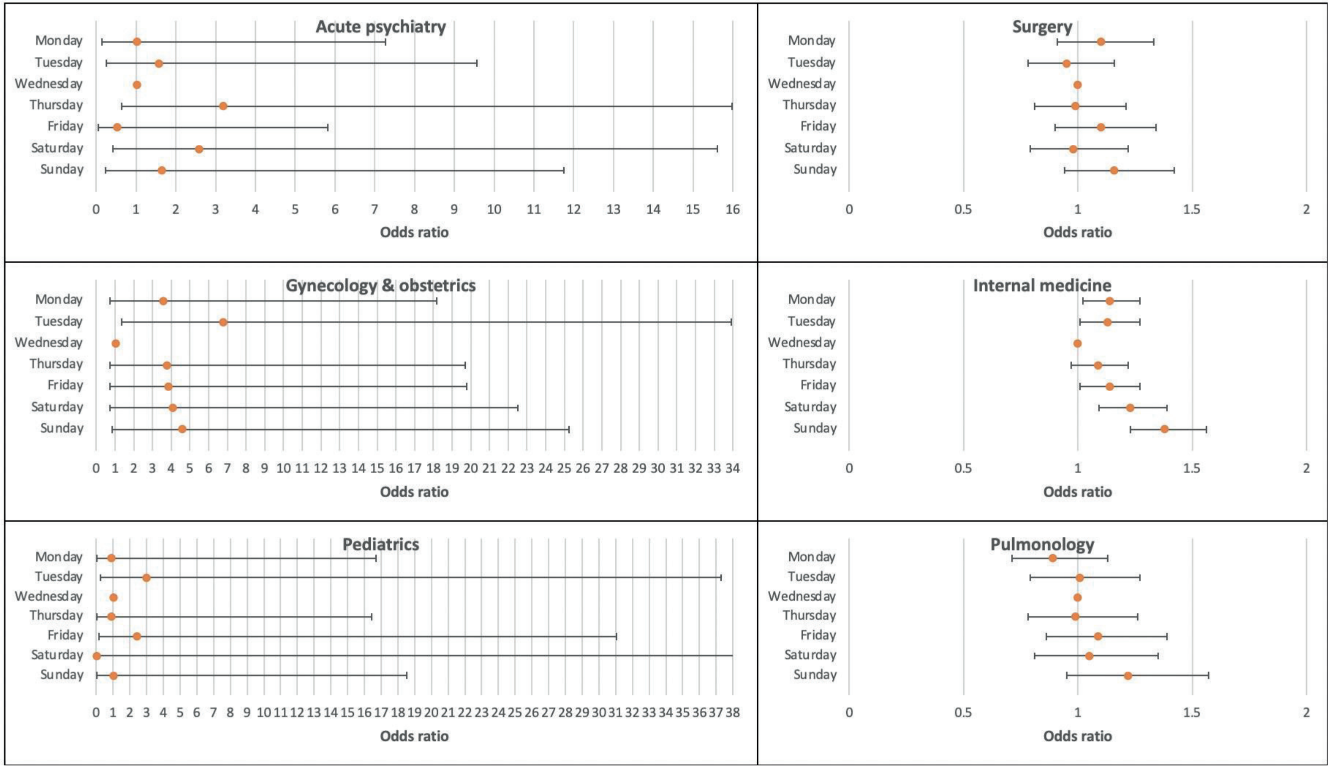


Figure 16 Adjusted odds of in-hospital mortality in 292,399 emergency admissions in six secondary hospitals in the Helsinki and Uusimaa Hospital District. The reference day (OR=1) is Wednesday.

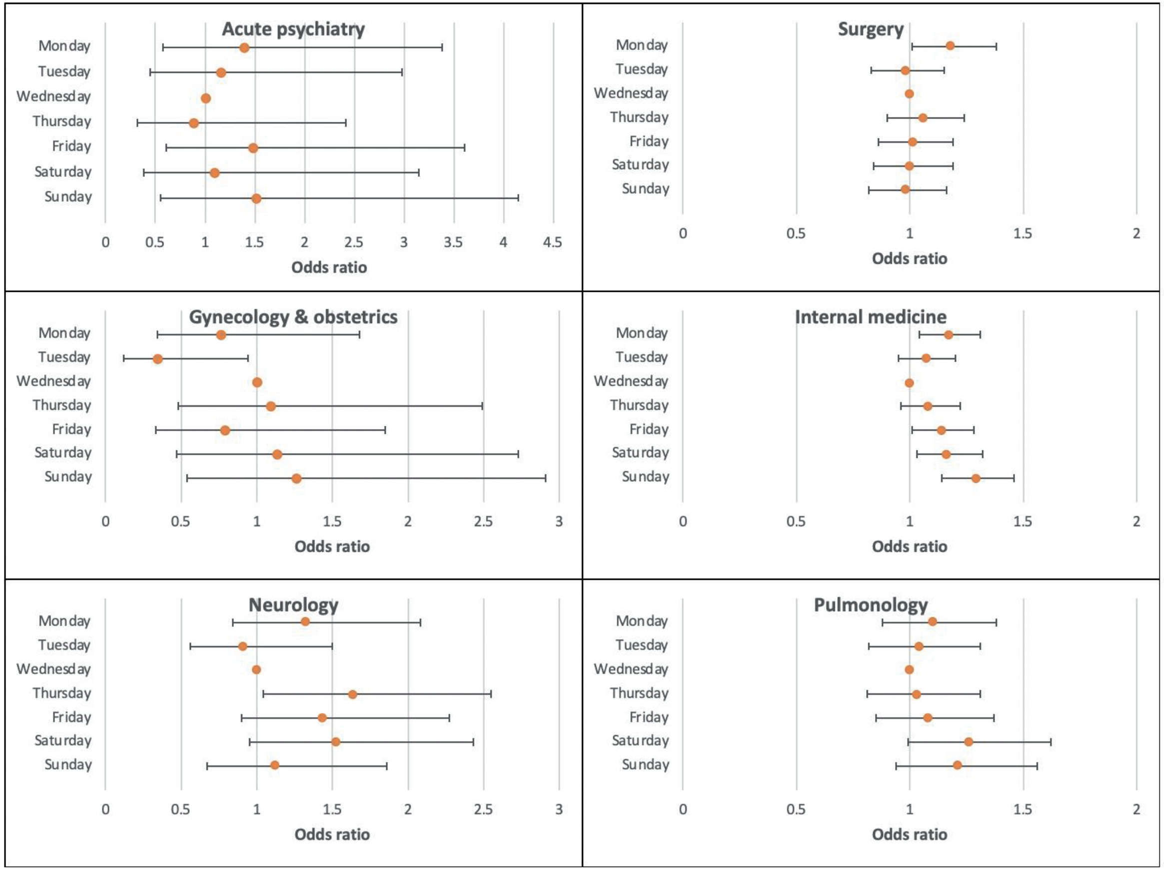
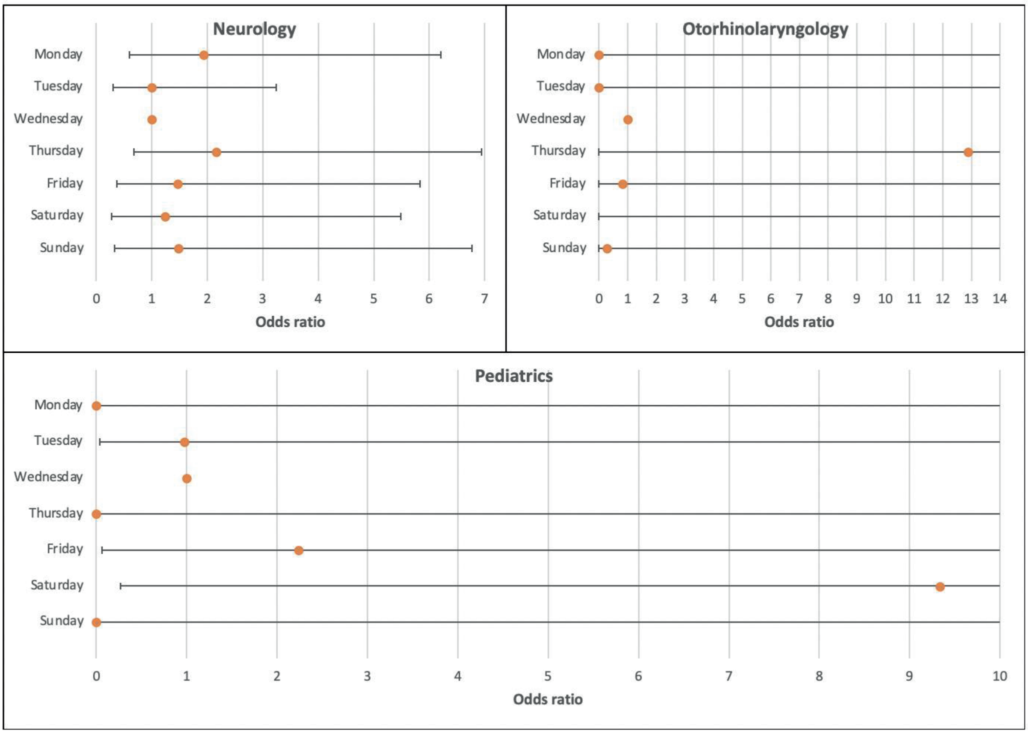


Figure 17 Adjusted odds of 30-day post-discharge mortality in 292,399 emergency admissions in six secondary hospitals in the Helsinki and Uusimaa Hospital District. The reference day (OR=1) is Wednesday. In the specialty of pediatrics, confidence interval was 0-Inf for all days and the odds ratios for Tuesday (OR $6.2*10^7$), Thursday (OR $8.3*10^7$), Friday (OR $3.8*10^7$), Saturday (OR $8.2*10^7$) and Sunday (OR $4.0*10^7$) were too large to visualize them in the same graph with Monday (OR 0.96).

5.2.6 ELECTIVE ADMISSIONS

Odds ratios of in-hospital mortality were lower in many specialties for elective admissions on weekdays compared with weekend elective admissions when adjusting for age, sex, risk category, weekday, year and month (Figure 18). Odds ratios of 30-day post-discharge mortality were higher in many specialties for elective admissions on weekdays compared with weekend elective admissions when adjusting for age, sex, risk category, weekday, year and month (Figure 19).



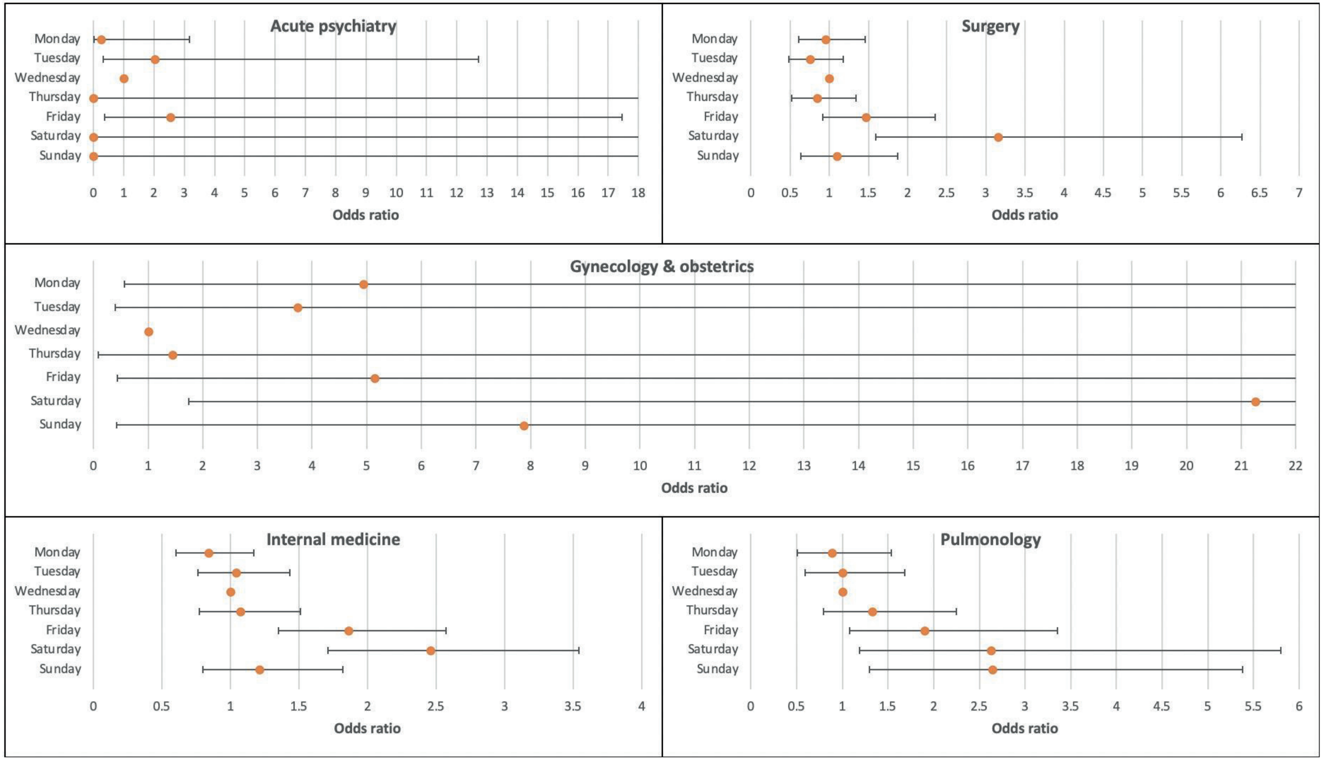


Figure 18 Adjusted odds of in-hospital mortality in 164,277 elective admissions in six secondary hospitals in the Helsinki and Uusimaa Hospital District. The reference day (OR=1) is Wednesday. The confidence intervals for some days were too large to visualize in the figures: acute psychiatry (Thursday, Saturday, Sunday, 95% CI 0-Inf), gynecology and obstetrics (Monday 95% CI 0.56-43.48, Tuesday 0.4-34.73, Thursday 0.09-23.98, Friday 0.44-60.61, Saturday 1.74-259.9, Sunday 0.42-147.4), otorhinolaryngology (Monday 95% CI 0-Inf, Tuesday 0-Inf, Thursday 0-Inf, Friday 0-Inf, Saturday OR 1.99×10^{14} 0-Inf, Sunday 0-Inf) and pediatrics (Monday 95% CI 0-Inf, Tuesday 0.04-23.59, Thursday 0-Inf, Friday 0.06-78.59, Saturday 0.27-324.34, Sunday 0-Inf).

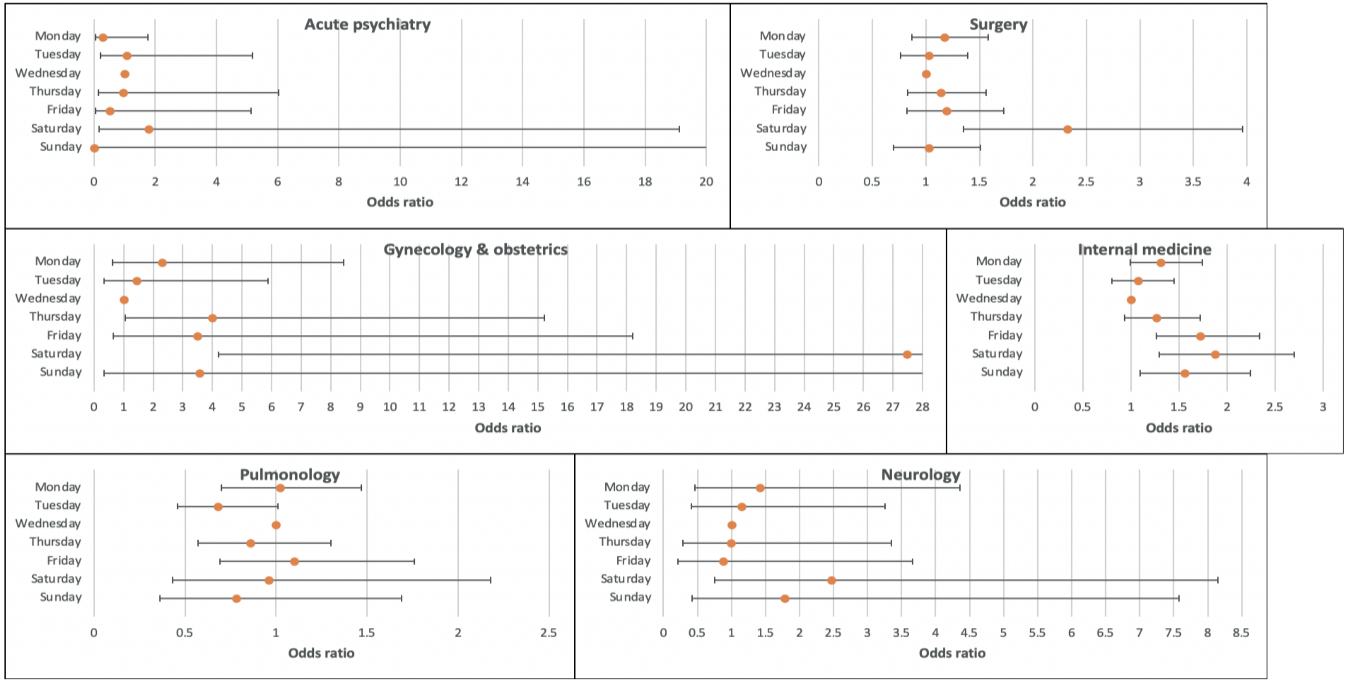


Figure 19 Adjusted odds of 30-day post-discharge mortality in 164,277 elective admissions in six secondary hospitals in the Helsinki and Uusimaa Hospital District. The reference day (OR=1) is Wednesday. The confidence intervals for some days were too large to visualize in the figures: acute psychiatry (Sunday 0-Inf), gynecology and obstetrics (Saturday 4.22-178.92, Sunday 0.34-38.12), pediatrics (Monday OR 0 0-Inf, Tuesday OR $6.69*10^{23}$ 0-Inf, Thursday OR $9.92*10^{16}$ 0-Inf, Friday $6.10*10^{18}$ 0-Inf, Saturday $1.35*10^{58}$ 0-Inf, Sunday $3.13*10^{21}$ 0-Inf) and otorhinolaryngology (Monday OR $1.73*10^{2}$ 0-Inf, Tuesday 0 0-Inf, Thursday 0 0-Inf, Friday 3.64 0-Inf, Saturday $9.93*10^{27}$ 0-Inf, Sunday $8.55*10^{14}$ 0-Inf).

5.2.7 MORTALITY BY YEAR AND SPECIALTY

The specialties most sensitive to the weekend effect in the secondary hospitals were surgery, internal medicine, and gynecology and obstetrics. Odds of mortality were adjusted for age, sex, risk category, weekday, year and month. Tables 10 and 11 show the years with a statistically significant risk: lower risk than 2010 highlighted in green, higher risk in yellow.

5.2.8 PREVENTABLE DEATHS

By calculating the crude mortality rates for Saturday and Sunday admissions and comparing them to the crude mortality rate of Wednesday, we can estimate the number of preventable deaths potentially attributable to the weekend effect. In secondary hospitals, these deaths numbered 1,170 (surgery n=358, internal medicine n=633, pediatrics n=6, gynecology and obstetrics n=19, neurology n=61, acute psychiatry n=4, pulmonology n=89, otorhinolaryngology n=0).

year	Surgery				Internal medicine			
	elective		emergency		elective		emergency	
	in-hospital	30-day	in-hospital	30-day	in-hospital	30-day	in-hospital	30-day
2000	0.95 (0.48-1.90)	2.75 (1.69-4.47)	2.70 (2.07-3.51)	1.39 (1.09-1.79)	1.23 (0.70-2.15)	2.67 (1.66-4.30)	1.91 (1.63-2.23)	0.84 (0.70-1.02)
2001	0.48 (0.19-1.20)	1.17 (0.65-2.08)	0.70 (0.50-0.99)	2.21 (1.78-2.75)	0.40 (0.15-1.09)	2.13 (1.22-3.74)	0.61 (0.50-0.74)	1.56 (1.34-1.81)
2002	1.31 (0.66-2.59)	1.46 (0.85-2.50)	1.73 (1.33-2.26)	1.37 (1.09-1.72)	1.46 (0.79-2.68)	1.10 (0.61-1.97)	1.52 (1.30-1.77)	1.04 (0.88-1.22)
2003	1.03 (0.51-2.08)	1.26 (0.72-2.18)	1.36 (1.03-1.79)	1.51 (1.21-1.89)	1.11 (0.57-2.17)	1.23 (0.68-2.24)	1.39 (1.18-1.62)	1.02 (0.86-1.20)
2004	0.65 (0.30-1.39)	1.03 (0.59-1.81)	1.60 (1.22-2.09)	0.98 (0.77-1.26)	1.67 (0.94-2.98)	1.58 (0.93-2.71)	1.22 (1.04-1.44)	0.92 (0.77-1.08)
2005	1.47 (0.79-2.74)	1.96 (1.20-3.21)	1.11 (0.82-1.49)	1.41 (1.12-1.78)	2.24 (1.35-3.71)	1.68 (1.04-2.69)	1.25 (1.06-1.48)	1.11 (0.93-1.31)
2006	0.83 (0.41-1.69)	1.01 (0.57-1.77)	1.47 (1.12-1.92)	1.25 (0.99-1.57)	2.07 (1.24-3.48)	1.55 (0.95-2.53)	1.18 (1.00-1.38)	0.83 (0.70-0.98)
2007	1.21 (0.61-2.42)	0.82 (0.43-1.53)	1.49 (1.15-1.95)	1.26 (1.0002-1.57)	1.52 (0.84-2.73)	1.39 (0.80-2.40)	1.11 (0.94-1.30)	0.75 (0.63-0.89)
2008	0.47 (0.19-1.16)	0.95 (0.52-1.73)	1.27 (0.96-1.66)	1.39 (1.12-1.74)	0.94 (0.49-1.79)	1.29 (0.74-2.25)	1.12 (0.95-1.32)	0.89 (0.76-1.05)
2009	0.65 (0.29-1.45)	1.09 (0.61-1.95)	1.03 (0.78-1.36)	1.02 (0.81-1.28)	1.65 (0.93-2.93)	1.26 (0.72-2.19)	1.07 (0.91-1.25)	0.95 (0.81-1.11)
2010	1	1	1	1	1	1	1	1
2011	0.60 (0.26-1.38)	0.76 (0.40-1.43)	1.10 (0.83-1.46)	1.23 (0.98-1.54)	1.00 (0.52-1.91)	0.96 (0.53-1.74)	0.96 (0.82-1.13)	0.83 (0.71-0.97)
2012	1.14 (0.57-2.27)	1.21 (0.69-2.13)	0.88 (0.65-1.19)	0.96 (0.75-1.23)	1.18 (0.63-2.22)	0.87 (0.47-1.62)	0.90 (0.77-1.05)	0.92 (0.79-1.07)
2013	0.33 (0.12-9.13)	0.86 (0.46-1.61)	0.76 (0.56-1.03)	0.88 (0.69-1.12)	1.24 (0.66-2.33)	1.20 (0.67-2.16)	0.96 (0.82-1.13)	0.92 (0.78-1.07)

Table 10. Adjusted odds of in-hospital and 30-day post-discharge mortality in emergency and elective admissions by specialty and year in secondary hospitals for the specialties of surgery and internal medicine. Reference year is 2010 (OR=1). Statistically significant ORs are highlighted: green lower risk, yellow higher risk.

	Neurology				Gynecology & obstetrics			
	elective		emergency		elective		emergency	
year	in-hospital	30-day	in-hospital	30-day	in-hospital	30-day	in-hospital	30-day
2000	0.00 (0-Inf)	0.42 (0.04-4.35)	0.40 (0.09-1.71)	0.14 (0.02-1.07)	2.31 (0-Inf)	7.17 (0.74-69.46)	0.85 (0.14-5.08)	1.15 (0.19-6.80)
2001	0.00 (0-Inf)	1.73 (0.28-10.74)	0.00 (0-Inf)	1.13 (0.42-3.03)	1.61 (0-Inf)	6.58 (0.71-61.23)	0.57 (0.12-2.73)	2.51 (0.72-8.72)
2002	5.39 (0.44-66.21)	0.86 (0.14-5.18)	0.74 (0.34-1.62)	0.51 (0.23-1.13)	1.88e+08 (0-Inf)	2.22 (0.21-23.31)	0.00 (0-Inf)	1.41 (0.36-5.57)
2003	2.93 (0.28-30.50)	0.80 (0.17-3.91)	0.75 (0.39-1.48)	0.36 (0.17-7.62)	4.11e+07 (0-Inf)	0.35 (0.02-6.44)	0.57 (0.13-2.48)	0.91 (0.23-3.56)
2004	1.03 (0.06-17.53)	0.22 (0.02-2.03)	1.00 (0.56-1.80)	0.47 (0.25-0.89)	4.65e+07 (0-Inf)	1.08 (0.09-13.52)	1.00 (0.25-4.02)	1.72 (0.47-6.22)
2005	2.83 (0.27-29.54)	0.71 (0.16-3.13)	0.78 (0.43-1.45)	0.53 (0.29-0.98)	2.14e+08 (0-Inf)	0.41 (0.03-6.11)	1.12 (0.30-4.20)	2.05 (0.60-7.05)
2006	4.22 (0.34-51.98)	1.22 (0.25-6.04)	0.82 (0.46-1.46)	0.72 (0.42-1.22)	3.49e+08 (0-Inf)	3.61 (0.34-38.16)	0.49 (0.08-2.91)	3.42 (0.95-12.30)
2007	8.12 (0.91-72.36)	0.51 (0.09-2.98)	0.79 (0.43-1.42)	0.71 (0.42-1.22)	1.21e+08 (0-Inf)	5.16 (0.46-57.39)	0.24 (0.04-1.38)	2.15 (0.64-7.19)
2008	1.76 (0.15-21.10)	1.41 (0.34-5.81)	0.94 (0.51-1.73)	0.48 (0.25-0.92)	1.46e+08 (0-Inf)	0.00 (0-Inf)	0.46 (0.10-2.18)	1.72 (0.49-6.07)
2009	4.69 (0.47-46.28)	0.53 (0.09-3.14)	0.62 (0.33-1.18)	0.89 (0.53-1.49)	2.01e+08 (0-Inf)	1.44 (0.08-26.14)	0.85 (0.20-3.62)	0.92 (0.22-3.87)
2010	1	1	1	1	1	1	1	1
2011	3.33 (0.34-32.11)	0.96 (0.24-3.87)	1.01 (0.58-1.74)	0.65 (0.38-1.11)	1.32 (0-Inf)	0.00 (0-Inf)	0.00 (0-Inf)	2.31 (0.65-8.15)
2012	5.73 (0.64-51.55)	0.44 (0.08-2.58)	0.71 (0.40-1.25)	0.78 (0.47-1.28)	1.31 (0-Inf)	4.06 (0.37-44.19)	0.39 (0.07-2.24)	1.44 (0.40-5.17)
2013	1.84 (0.18-19.22)	0.88 (0.20-3.84)	0.76 (0.44-1.29)	0.72 (0.45-1.16)	2.76 (0-Inf)	0.00 (0-Inf)	0.42 (0.04-4.12)	0.56 (0.06-5.29)

Table 11. Adjusted odds of in-hospital and 30-day post-discharge mortality in emergency and elective admissions by specialty and year in secondary hospitals for the specialties of neurology and gynecology & obstetrics. Reference year is 2010 (OR=1). Statistically significant ORs are highlighted: green lower risk, yellow higher risk.

5.3 EAR, NOSE AND THROAT DAY SURGERY

Of the procedures included in Study III, day surgery was performed on 1,011 ENT patients (Table 12). Three outcomes were investigated in patients having undergone ENT day surgery from January 1 to March 31, 2015: overstay, readmission and contacts. Nausea or vomiting (n=8) and operation site bleeding (n=5) were the most common reasons for overstays (n=20). Table 13 shows all of the causes of overstay. Thirteen patients experienced 14 readmissions and 116 patients 149 contacts during the 30-day follow-up period, with all of the causes presented in Tables 14 and 15.

Twenty-six phone calls were included in the contact group. Most were for the prescribing of antibiotics or pain medication. Altogether 138 patients experienced an outcome, leading to an overstay rate of 2.0%, a readmission rate of 1.4% and a contact rate of 14.7%. Only patients undergoing septocolumelloplasty (n=14) and biopsy of the larynx (n=8) avoided all of the study outcomes. No deaths occurred during the follow-up period.

Post-tonsillectomy hemorrhage occurred in 14.9% of patients (n=29): 24 were treated under local anesthesia with bipolar coagulation, for six patients bleeding subsided before reaching the hospital, and for three small children (age <6 years old) coagulation was performed under general anesthesia due to age, not bleeding severity. Post-tonsillotomy bleeding took place in 2.6% of cases (n=2) and post-adenoidectomy in 1.3% (n=2).

Female sex (unadjusted OR 1.79, 95% CI 1.24-2.57, p=0.002), age groups 16-44 years (unadjusted OR 3.27, 95% CI 2.10-5.10, p<0.001) and 45-64 years (unadjusted OR 2.05, 95% CI 1.16-3.61, p=0.013) were statistically significant factors in univariable logistic regression for an outcome after day surgery. The associations of various factors with an outcome of overstay, readmission or contact by multivariable logistic regression are expressed in Table 16.

	Ear surgery	Nasal surgery	Tonsil & adenoid surgery	Miscellaneous ENT procedures	Hand surgery	Shoulder & elbow surgery	Lower limb surgery
***Patients* (n)**	236	256	400	119	471	55	16
***Male* %**	51.7	53.5	53.8	55.5	37.4	58.2	56.3
***Age* median (range)**	4.3 (0.5 - 76.2)	40.7 (3.4 - 81.4)	9.2 (0.6 - 70.7)	50.5 (2.6 - 87.0)	53.8 (16.2 - 92.5)	54.3 (23.2 - 72.2)	42.2 (21.1 - 63.3)
***ASA class* median (range)**	1 (1 - 3)	1 (1 - 3)	1 (1 - 4)	2 (1 - 4)	2 (1 - 4)	2 (1 - 4)	1 (1 - 3)
Anesthesia							
Local (%)	16.9	73.7		47.1	42.7	10.9	
Regional (%)					49.7	65.5	93.7
General (%)	83.1	26.3	100	52.9	7.6	23.6	6.3

Table 12. Patient characteristics in 1,011 ENT and 542 OHS day surgery procedures. Modified with permission from Tolvi et al. Overstay and readmission in ear, nose and throat day surgery – factors affecting postanesthesia course. Ear, Nose & Throat J. 2019; 145561319872165 and Tolvi et al. Root causes of extended length of stay and unplanned readmissions after orthopedic surgery and hand surgery: a retrospective observational cohort study. Patient Saf Surg. 2020;14:27.

	Overstay (no. of patients)	% of all patients	Ear surgery	Nasal surgery	Tonsil & adenoid surgery	Miscellaneous ENT procedures
nausea/vomiting	8	0.8	2		5	1
operation site bleeding	5	0.5		2	2	1
fatigue	2	0.2	1		1	
extensive surgery	2	0.2		1		1
pain	1	0.1		1		
dizziness	1	0.1			1	
slow recovery from anesthesia	1	0.1				1
Total	20	2.0	3	4	9	4

Table 13. Reasons for overstay in 1,011 ENT day surgery patients.

	No. of patients	Readmissions (n)	% of all patients	Ear surgery	Nasal surgery	Tonsil & adenoid surgery	Miscellaneous ENT procedures
Readmissions related to surgery							
Operation site bleeding	3	3	0.3			3	
Dizziness	3	3	0.3	3			
Acute kidney failure/dialysis (aspiration pneumonia, ICU, sepsis)	1	1	0.1			1	
Readmissions not related to surgery							
Obstructive bronchitis	1	1	0.1	1			
Seizures	2	3	0.2	2		1	
Pulmonary empyema	1	1	0.1			1	
Pneumonia	1	1	0.1			1	
Unspecified bacterial infection	1	1	0.1		1		
Total	13	14	1.3	6	1	7	0

Table 14. Reasons for readmission in 1,011 ENT day surgery patients.

	No. of patients	Contacts	% of all patients	Ear surgery	Nasal surgery	Tonsil & adenoid surgery	Miscellaneous ENT procedures
Revisits related to surgery							
Operation site bleeding	32	39	3.2	4	7	27	1
Pain	21	25	2.1	3	3	19	
Pressure/swelling/nasal stuffiness	12	14	1.2		8	4	2
Operation site infection	8	11	0.8	8	2	1	
Fever	6	9	0.6	1	6	2	
Coating/secretion on mucous membranes	5	7	0.5		5	2	
Dizziness	2	6	0.2	6			
Facial nerve paresis	1	3	0.1	3			
Ranula/seroma	2	3	0.2				3
Nausea/vomiting	2	2	0.2			2	
Nasal regurgitation/dysphagia	2	2	0.2			2	
Operation site abscess	1	2	0.1				2
Wound dehiscence	1	1	0.1				1
Hole in palatopharyngeal arch	1	1	0.1			1	
Wrong lump removed	1	1	0.1				1
Revisits not related to surgery							
Seizures	1	2	0.1	2			
Physical assault/head injury	1	2	0.1	2			
Clavicle fracture	1	2	0.1			2	
Abdominal pain	1	2	0.1			2	
Upper respiratory infection	2	2	0.2	1			1
Joint pain	1	1	0.1		1		
Knee injury	1	1	0.1		1		
Tourist diarrhea	1	1	0.1		1		
Conjunctivitis	1	1	0.1			1	
Obstructive bronchitis	1	1	0.1	1			
Dyspnea/pleural puncture	1	1	0.1				1
Patient request	7	7	0.7	1	6		
Total	116	149	11.5	32	40	65	12

Table 15. Reasons for contact in 1,011 ENT day surgery patients.

Overstays or readmissions were seen for 3.2% general anesthesia patients (n=23) and 1.4% for local anesthesia (n=4). Less than half of contacts (42.3%, n=63) involved local anesthesia. The form of anesthesia for each procedure group is listed in Table 12. General anesthesia was used for all tonsil and adenoid surgery. Tube insertions were the most common ear procedure. Most of these were performed on small children and therefore, were carried out under general anesthesia. Half of all other ear procedures were done under local anesthesia and half under general anesthesia. The majority of nasal surgeries were carried out under local anesthesia with the exception of ethmoidectomies (57%, n=12 general anesthesia).

Factor	**n (%) of outcomes**	**Adjusted* OR (95% CI)**	**P-value**
Sex (n=1011)			
Male	57 (10.5)	1	
Female	81 (17.3)	1.53 (1.05-2.24)	0.028
Age (n=1011)			**0.000**
0-15 years	31 (7.4)	1	
16-44 years	77 (20.8)	3.63 (2.21-5.95)	0.000
45-64 years	24 (14.1)	2.30 (1.17-4.52)	0.015
65+ years	6 (11.1)	1.75 (0.60-5.09)	0.302
Anesthesia (n=1007)			
Local	43 (15.4)	1	
General	95 (13.1)	0.93 (0.52-1.64)	0.795
ASA class (n=986)			**0.151**
1	83 (12.5)	1	
2	44 (15.9)	1.34 (0.87-2.05)	0.183
3-4	9 (20.0)	2.09 (0.90-4.86)	0.087
Type of procedure (n=1011)			**0.105**
Ear surgery	25 (10.6)	2.04 (0.91-4.56)	0.085
Nasal surgery	41 (16.0)	1.74 (0.83-3.65)	0.141
Tonsil & adenoid surgery	60 (15.0)	2.61 (1.22-5.62)	0.014
Miscellaneous procedures	12 (10.1)	1	

*Table 16. The associations of factors with overstay, readmission or contact by multivariable logistic regression analysis. *Adjusted for all other variables in the model (n=986). Modified with permission from Tolvi et al. Overstay and readmission in ear, nose and throat day surgery – factors affecting postanesthesia course. Ear, Nose & Throat J. 2019; 145561319872165.*

5.4 ORTHOPEDIC AND HAND DAY SURGERY

Three outcomes were investigated in patients having undergone OHS day surgery from January 1 to March 31, 2015: overstay, readmission and contacts. Day surgery was performed on 542 orthopedic and hand surgery patients. Patient characteristics are presented in Table 12. Four overstays, as well as six readmissions in five patients occurred during the 30-day follow-up period (Tables 17 and 18). Readmissions only took place in the upper limb surgery groups. Thirty-six patients experienced 49 contacts, with all causes presented in Table 19. Five phone calls were included.

	Overstay (no. of patients)	% of all patients	Hand surgery	Shoulder & elbow surgery	Lower limb surgery
Pain	2	0.4	1	1	
Nausea/vomiting	2	0.4	2		
Total	4	0.7	3	1	0

Table 17. Reasons for overstays in 542 OHS day surgery patients.

	No. of readmitted patients	Readmissions (n)	% of all patients	Hand surgery	Shoulder & elbow surgery	Lower limb surgery
Operation site abscess	1	2	0.2	2		
Epigastric pain & emergency gastroscopy	1	1	0.2	1		
I.v. line related infection	1	1	0.2		1	
Chest pain beginning after surgery	1	1	0.2	1		
NSTEMI (pain 2 days before procedure)	1	1	0.2	1		
Total	5	6	0.9	5	1	0

Table 18. Reasons for readmissions in 542 OHS day surgery patients. i.v. = Intravenous. NSTEMI = Non-ST segment elevation myocardial infarction.

	No. of patients	Contacts	% of all patients	Hand surgery	Shoulder & elbow surgery	Lower limb surgery
Revisits related to surgery						
Operation site infection	5	11	0.9	11		
Pain	6	6	1.1	6		
Swelling	3	5	0.6	5		
Problems with cast	3	4	0.6	4		
Operation site bleeding/hematoma	3	4	0.6	4		
Wound dehiscence	3	3	0.6	3		
Macerated wound	1	2	0.2	2		
Dysfunction	2	2	0.4	2		
Allergic reaction to antibiotic	1	1	0.2	1		
Fever	1	1	0.2		1	
Operation site abscess	1	1	0.2	1		
Hypertensive crisis	1	1	0.2	1		
Revisits not related to surgery						
Wrist fracture (due to fall)	2	3	0.4	3		
Patient's request	2	3	0.4	2	1	
No reason known	2	2	0.4		1	1
Total	36	49	6.6	45	3	1

Table 19. Reasons for contacts of 542 OHS day surgery patients.

Altogether, the overstay rate was 0.7%, readmission rate 1.1% and contact rate 9.0%. Radical excision of soft tissue tumor of wrist or hand (n=17) and arthroscopic partial excision of meniscus of knee (n=16) involved no study outcomes. No deaths took place during the follow-up period.

Regional or local anesthesia was used for most procedures. General anesthesia was involved in all overstays and half of readmissions. Half of these overstays, and all of these readmissions, were suffered by patients undergoing partial fusion of the wrist with bone graft under general anesthesia. Of 49 contacts, 11 were general anesthesia patients.
Sex, fentanyl, other pain medication during procedure, administration of remifentanil and administration of antiemetic medication rose to statistical

significance ($p<0.05$) for an outcome of overstay, readmission or contact (Tables 20, 23 and 24).

Factor	No. of patients	n (%) of outcomes	P-value
Sex	**542**		**0.043**
Male	217	9 (4.1)	
Female	325	28 (8.6)	
Age (years)	**542**		**0.465**
16-44	153	9 (5.9)	
45-64	292	20 (6.8)	
65-74	68	4 (5.9)	
75+	29	4 (13.8)	
BMI (kg/m^2)	**542**		**0.422**
<20	29	1(3.4)	
20-24.9	183	8 (4.4)	
25-29.9	176	16 (9.1)	
30.0-34.9	102	9 (8.8)	
35-39.9	32	1 (3.1)	
40-44.9	16	2 (12.5)	
45-49.9	3	0 (0)	
50-54.9	1	0 (0)	
ASA class	**539**		**0.226**
1	176	9 (5.1)	
2	228	13 (5.7)	
3-4	135	13 (9.6)	
Smoking status	**534**		**0.549**
no	378	22 (5.8)	
yes	140	12 (8.6)	
quit	12	1 (8.3)	
sometimes	4	0 (0)	

Table 20. Patient related factors and their effect on postoperative outcome in OHS day surgery. BMI = body mass index, ASA = American Society of Anesthesiologists. Modified with permission from Tolvi et al. Root causes of extended length of stay and unplanned readmissions after orthopedic surgery and hand surgery: a retrospective observational cohort study. Patient Saf Surg. 2020;14:27.

Factor	No. Of patients	n (%) of outcomes	P-value
Cardiovascular disease	**542**		**0.96**
yes	203	14 (6.9)	
no	339	23 (6.8)	
Anticoagulant	**541**		**0.683**
no	525	36 (6.9)	
warfarin	8	1 (12.5)	
aspirin	6	0 (0)	
NOAC	2	0 (0)	
Diabetes	**542**		**0.17**
yes	61	7 (11.5)	
no	481	30 (6.2)	
Pulmonary disease	**542**		**0.413**
yes	60	2 (3.3)	
no	482	35 (7.3)	
Sleep apnea	**542**		**0.386**
yes	20	0 (0)	
no	522	37 (7.1)	
Migraine/headache	**542**		**0.576**
yes	12	1 (8.3)	
no	530	36 (6.8)	
Psychiatric condition	**542**		**0.512**
yes	41	4 (9.8)	
no	501	33 (6.6)	
Meniere/vertigo	**542**		**1**
yes	3	0 (0)	
no	539	37 (6.9)	
Immunosuppression	**542**		**0.639**
yes	20	2 (10.0)	
no	522	35 (6.7)	
Other underlying medical condition	**542**		**0.837**
yes	118	7 (5.9)	
no	424	30 (7.1)	

Table 21. Underlying medical conditions and medications and their effects on OHS day surgery. NOAC = novel oral anticoagulant. Modified with permission from Tolvi et al. Root causes of extended length of stay and unplanned readmissions after orthopedic surgery and hand surgery: a retrospective observational cohort study. Patient Saf Surg. 2020;14:27.

Factor	No. Of patients	N (%) of outcomes	P-value
Premedication paracetamol	**539**		**1**
yes	510	35 (6.9)	
no	29	2 (6.9)	
Premedication NSAID	**539**		**0.423**
yes	339	21 (6.2)	
no	200	16 (8.0)	
Premedication diazepam	**539**		**0.391**
yes	226	18 (8.0)	
no	313	19 (6.1)	

Table 22. Premedications and their effect on outcomes in OHS day surgery. NSAID = nonsteroidal anti-inflammatory drug. Reproduced with permission from Tolvi et al. Root causes of extended length of stay and unplanned readmissions after orthopedic surgery and hand surgery: a retrospective observational cohort study. Patient Saf Surg. 2020;14:27.

Factor	No. Of patients	N (%) of outcomes	P-value
Antiemetic medication	**540**		**0.107**
no	519	33 (6.4)	
ondansetron 4mg	20	4 (20.0)	
metoclopramide 10mg	1	0 (0)	
Antiemetic medication	**540**		**0.048**
yes	21	4 (19.0)	
no	519	33 (6.4)	

Table 23. Perioperative antiemetic use and their effect on outcomes in OHS day surgery. Modified with permission from Tolvi et al. Root causes of extended length of stay and unplanned readmissions after orthopedic surgery and hand surgery: a retrospective observational cohort study. Patient Saf Surg. 2020;14:27.

Oxycodone, general anesthesia, plexus block and postoperative pain medication were borderline significant ($p<0.10$) (Tables 24, 25 and 26).

Risk profiles were formed using assorted combinations of these factors (Table 28). Other pain medication during procedure and postoperative pain medication were not included in the risk profile due to small sample size when combined with another risk factor. The reference cohort of each profile was those patients, who did not have the characteristics of the risk profile.

Factor	No. Of patients	N (%) of outcomes	P-value
Oxycodone i.v. (mg)	**539**		**0.064**
0-10	525	34 (6.5)	
>10	14	3 (21.4)	
Fentanyl i.v. (mg)	**539**		**0.00**
0-0.15	502	29 (5.8)	
>0.15	37	8 (21.6)	
Other pain medication during procedure	**539**		**0.005**
no	527	33 (6.3)	
NSAID (ketoprofen)	1	0 (0)	
paracetamol	3	2 (66.7)	
other strong analgesic (alfentanil, esketamine)	8	2 (25.0)	
Remifentanil	**542**		**0.036**
yes	48	7 (14.6)	
no	494	30 (6.1)	
Propofol	**542**		**0.117**
no	476	29 (6.1)	
general anesthesia	55	7 (12.7)	
sedation	11	1 (9.1)	
Sevoflurane	**542**		**1**
yes	1	0 (0)	
no	541	37 (6.8)	
Glycopyrrolate	**542**		**0.656**
yes	22	2 (9.1)	
no	520	35 (6.7)	
Dexamethasone	**542**		**0.111**
yes	45	6 (13.3)	
no	497	31 (6.2)	
Rocuronium	**541**		**0.247**
yes	4	1 (25.0)	
no	537	36 (6.7)	

Table 24. Intraoperative pain medication and anesthesia drugs used during procedures and their effect on outcomes in OHS day surgery. i.v. = intravenous. Modified with permission from Tolvi et al. Root causes of extended length of stay and unplanned readmissions after orthopedic surgery and hand surgery: a retrospective observational cohort study. Patient Saf Surg. 2020;14:27.

Factor	No. Of patients	N (%) of outcomes	P-value
Postoperative pain medication	**539**		**0.08**
no	520	34 (6.5)	
NSAID (ibuprofen, ketoprofen)	8	0 (0)	
paracetamol	9	3 (33.3)	
weak opioids (paracetamol-codeine)	1	0 (0)	
strong analgesics (esketamine)	1	0 (0)	

Table 25. Postoperative pain medication and its effect on outcomes in OHS day surgery. Modified with permission from Tolvi et al. Root causes of extended length of stay and unplanned readmissions after orthopedic surgery and hand surgery: a retrospective observational cohort study. Patient Saf Surg. 2020;14:27.

Factor	No. of patients	n (%) of outcomes	P-value
General anesthesia	**542**		**0.077**
yes	53	7 (13.2)	
no	489	30 (6.1)	
Plexus block	**541**		**0.086**
yes	166	16 (9.6)	
no	375	21 (5.6)	
Intravenous regional anesthesia	**542**		**0.456**
yes	114	6 (5.3)	
no	428	31 (7.2)	
Spinal anesthesia	**542**		**0.617**
yes	16	0 (0)	
no	526	37 (7.0)	
Infiltrative anesthesia	**542**		**0.544**
yes	326	24 (7.4)	
no	216	13 (6.0)	
Peripheral nerve block	**542**		**1**
yes	18	1 (5.6)	
no	524	36 (6.9)	

Table 26. Type of anesthesia and its effect on outcomes in OHS day surgery. Modified with permission from Tolvi et al. Root causes of extended length of stay and unplanned readmissions after orthopedic surgery and hand surgery: a retrospective observational cohort study. Patient Saf Surg. 2020;14:27.

Factor	No. Of patients	n (%) of outcomes	P-value
Procedure group	**542**		**0.835**
Hand surgery	471	33 (7.0)	
Shoulder & elbow surgery	55	4 (7.3)	
Lower limb surgery	16	0 (0)	
Laryngeal mask airway or intubation	**542**		**0.137**
neither	488	30 (6.1)	
laryngeal mask airway	51	7 (13.7)	
intubation	3	0 (0)	
NRS recovery room	**539**		**0.384**
no pain 0	467	31 (6.6)	
mild 1-3	41	3 (7.3)	
moderate 4-6	27	2 (7.4)	
severe 7-10	4	1 (25.0)	
Hypotensive during procedure	**540**		**0.794**
yes	66	5 (7.6)	
no	474	32 (6.8)	
Hypertensive during procedure	**540**		**0.959**
yes	396	27 (6.8)	
no	144	10 (6.9)	

Table 27. Miscellaneous perioperative factors and their effects on OHS day surgery. NRS = numerical rating system. Modified with permission from Tolvi et al. Root causes of extended length of stay and unplanned readmissions after orthopedic surgery and hand surgery: a retrospective observational cohort study. Patient Saf Surg. 2020;14:27.

Paracetamol, etoricoxib and diazepam are the standard premedication at the OHS day surgery unit, with the majority of patients receiving some combination of these adjusted according to allergies and possible medication in use. Along with oxycodone, fentanyl and remifentanil, intraoperative pain medication also included paracetamol, NSAIDs and other strong analgesics (Table 24). Combinations varied from patient to patient. NSAIDs, paracetamol, weak opioids and strong analgesics were administered for postoperative pain, in addition to the aforementioned oxycodone. The average of NRS pain scores was drawn on in this study. The risk of an outcome was significant for patients receiving antiemetic drugs (p=0.048) but the actual drug was not significant (p=0.107).

Combination	n of patients (total N)	OR (95% CI)	P-value	PPV	NPV	Specificity	Sensitivity
Female & Fentanyl ≥0.16mg i.v.	16 (539)	6.97 (2.29-21.29)	<0.001	31.3%	93.9%	97.8%	13.5%
Female & Remifentanil	18 (542)	4.25 (1.33-13.64)	0.015	22.2%	93.7%	97.2%	10.8%
Fentanyl ≥0.16mg i.v. & Remifentanil	26 (539)	5.93 (2.31-15.21)	<0.001	26.9%	94.2%	96.2%	18.9%
Female & Fentanyl ≥0.16mg i.v. & Remifentanil	8 (539)	15.09 (3.61-63.06)	<0.001	50.0%	93.8%	99.2%	10.8%
Fentanyl ≥0.16mg i.v. & General anesthesia	30 (539)	4.86 (1.93-12.23)	<0.001	23.3%	94.1%	95.4%	18.9%
Fentanyl ≥0.16mg i.v. & Plexus block	18 (538)	5.87 (1.97-17.47)	0.001	27.8%	93.8%	97.4%	13.5%
Fentanyl ≥0.16mg i.v. & Remifentanil & General anesthesia	26 (539)	5.93 (2.31-15.21)	<0.001	26.9%	94.2%	96.2%	18.9%
Female & Fentanyl ≥0.16mg i.v. & General anesthesia	10 (539)	10.02 (2.70-37.26)	<0.001	40.0%	93.8%	98.8%	10.8%
Female & Fentanyl ≥0.16mg i.v. & Plexus block	6 (538)	14.65 (2.85-75.33)	0.001	50.0%	93.6%	99.4%	8.1%
Female & Antiemetic medication	13 (540)	6.65 (1.95-22.75)	0.003	30.8%	93.7%	98.2%	10.8%
Fentanyl ≥0.16 & Antiemetic medication	14 (539)	2.33 (0.50-10.84)	0.280	14.3%	93.3%	97.6%	5.4%

Table 28 Various risk profiles for outcomes in OHS day surgery. OR = odds ratio, CI = confidence interval, PPV = positive predictive value, NPV = negative predictive value, i.v. = intravenous. Modified with permission from Tolvi et al. Root causes of extended length of stay and unplanned readmissions after orthopedic surgery and hand surgery: a retrospective observational cohort study. Patient Saf Surg. 2020;14:27.

6 DISCUSSION

6.1 WEEKEND EFFECT (STUDY I AND II)

6.1.1 MORTALITY BY YEAR

Annual mortality variation may be attributable to assorted events. When examining mortality by year, a clear spike is seen in 2001 at Helsinki University Hospital. A sharp rise also occurred in the secondary hospitals the same year. The joining of two secondary hospitals to the university hospital is one possible explanation, with organizational changes and rearranging of services temporarily affecting mortality. This explanation seems most likely as for the university hospital for all the years after 2001 up until 2007 mortality undulates on both sides of the base line of one. From then onwards, there is a steady decline.

From March to August 2001, doctors went on strike in Finland, increasing wait times for treatment. This especially affected surgical specialties. The strike and its fall-out are another possible explanation for the spike in mortality seen in 2001[192,193]. The backlog of surgeries caused by the strike continued into 2002 and the year also saw the bombing of Myyrmanni shopping center in October[194]. In addition to the joining of two secondary hospitals to the university hospital, the round-the-clock on-call procedural cardiology service began and the centralization of the thrombolysis of stroke patients to the university hospital occurred in 2001[195]. A wing of 12 new operating rooms were taken into use in the university hospital in 2001[193]. The centralization of rare and difficult treatments to the university hospital by decision of the hospital board materialized in 2002. This course of action was carried on in 2003 with the centralization of oncologic surgery, pulmonary surgery and procedures that are performed less than 50 times per year. The year 2003 also brought about the launch of the new emergency department and the centralization of more challenging emergency patients to the department, along with the implementation of a new clinical data processing system[196]. April 2005 saw the centralization of the treatment of ST-elevation myocardial infarctions from beginning to end to the university hospital. The elimination of redundant and overlapping processes and operations was undertaken in 2006[197]. The commencement of the renovation of the main building of the university hospital gave rise to the sprinkling of specialties around the city at the end of 2010 and continuing in 2011[195].

When comparing overall weekend mortality to overall weekday mortality on an annual level, the odds for a weekend admission ending in death in hospital or 30 days post-discharge at the university hospital were at their highest in 2002 and their lowest in 2013.

6.1.2 MORTALITY BY SPECIALTY

Acute psychiatry patients had no weekend effect in in-hospital mortality in Studies I and II, which is in line with a previous study[198]. There was also no weekend effect in 30-day mortality in either Study I or II. In a previous study, in-hospital and 30-day post-admission mortality due to suicide were higher for weekday admissions[199].

Elective surgery patients admitted on the weekend had a significant risk for in-hospital mortality at both university and secondary hospitals and for 30-day post-discharge mortality at secondary hospitals, which coincides with a recent Canadian study[200].

Weekend effects for both elective in-hospital and 30-day post-discharge mortality in university and secondary hospitals, as well as emergency in-hospital mortality for the university hospital, exist for gynecology and obstetrics patients in Studies I and II. Conflicting results concerning obstetrics patients and a weekend effect have been presented[138–144].

In Studies I and II, a weekend effect was observed for elective pulmonology patients in in-hospital mortality in secondary hospitals, in addition to emergency patients in in-hospital mortality in the university hospital. In previous studies, no weekend effect among patients suffering from acute bacterial pneumonia or aspiration pneumonia were found[132,201]. A significant weekend effect was found for pulmonary embolism patients[133,201], while chronic obstructive pulmonary disease patients had a weaker effect. These previous studies, however, only comprised three diseases, whereas Studies I and II examined all pulmonology patients.

For elective neurology patients there was a weekend effect in in-hospital and 30-day post-discharge mortality at Helsinki University Hospital. In addition, emergency patients suffered from the weekend effect in in-hospital mortality. While neurology patients are treated in both secondary and university hospitals, ischemic stroke treatment and intravenous thrombolysis are centralized to the university hospital stroke unit in the hospital district. A previous study at the unit did not find a weekend effect[6]. However, a weekend effect for stroke patients has been found elsewhere[134].

No weekend effect was found in Studies I and II for otorhinolaryngology patients. A literature search found no studies on the subject in these patients.

A recent literature review concluded that no weekend effect existed among pediatric patients[202]. However, disease-specific studies showed a weekend effect for pediatric epilepsy patients[203] and ischemic and hemorrhagic strokes[204]. Nevertheless, our studies found no weekend effect in pediatric patients.

Neurosurgical emergency patients had a weekend effect in in-hospital mortality. Traumatic brain injuries were found to have a weekend effect in a systematic review and meta-analysis[201]. A similar finding was observed in in-hospital and 30-day mortality in pediatric neurosurgery patients[205]. The findings of these studies of a weekend effect could, of course, be due to the increase of risky behavior during the weekend in the form of e.g. increased alcohol use.

Oncologic patients experienced a higher risk for in-hospital mortality for emergency admissions in the university hospital. These results are in line with a recent systematic review and meta-analysis showing a significant weekend effect for breast cancer, respiratory neoplasm, pancreatic cancer, malignant neoplasm of genitourinary organs and colorectal cancer[201].

Geriatric internal medicine patients had a small but statistically insignificant weekend effect, which was suspected to be caused by a higher level of illness at the weekend[206]. The patients in HUS experienced no statistically significant weekend effects.

Internal medicine patients admitted on the weekend had a higher risk for in-hospital mortality, intubation, mechanical ventilation, cardio-pulmonary resuscitation and ICU care than those admitted during the week[207]. Leukemia, arrhythmia and cardiac arrest, lymphoma, renal failure, heart failure, myocardial infarction and bloodstream infection weekend effect were found in a recent systemic review and meta-analysis[201]. In our data, there was a weekend effect for emergency patients in in-hospital and 30-day post-discharge mortality, as well as for elective patients in in-hospital mortality, in both university and secondary hospitals. Furthermore, there was also a weekend effect in elective patients in 30-day post-discharge mortality in secondary hospitals. The university hospital cares for the most medically challenging and riskiest patients, e.g. ST-elevation myocardial infarctions. The emergency department of a secondary hospital is often where fourth year medical students start their career as doctors, more specifically the internal medicine service. This service in the emergency department is also commonly staffed with junior residents. The transfer of patients to the university hospital may be impeded by inexperience and, in turn, this might elevate the risk of mortality. In comparison, the specialty of anesthesiology is comprised of ICU patients - the sickest patients in the hospital with the highest mortality risk – and yet these patients had no statistically significant weekend effect in Study I. This may attest to the effect of continuous senior staffing on the weekend effect. However, statistically insignificant end-of-the week effects were visible on Mondays and Fridays, which is in line with a previous study, which found that mortality was highest amongst ICU patients Friday through Monday[208].

The seven-day-a-week service has been proposed as a remedy to these issues, with encouraging results in internal medicine[209]. Four priority clinical standards for emergency hospital care (time to first consultant review, access to diagnostics, access to consultant directed interventions and ongoing consultant review) have been implemented by the English NHS to tackle the weekend effect but so far these attempts have been futile[210]. The emergency medicine specialty was established in 2013 in Finland to combat these problems and streamline the emergency department. However, coding for this specialty was commenced in 2014 and therefore, the effects of this specialty are not seen in this research.

The lack of research on the pathways of care leading up to hospital admission was recently criticized and put forth as the real reason for the weekend effect, instead of deterioration in care at the weekend[211]. Nonetheless, a weekend effect was seen in Studies I and II despite the fact that the pathway to hospital admission is identical on weeknights and weekends. In addition, this effect was only visible in certain specialties and did not affect the sickest intensive care patients at all.

6.1.3 ELECTIVE AND EMERGENCY ADMISSIONS

Elective patients had a significant weekend effect in many specialties both in in-hospital and post-discharge mortality. Similar results were seen in a recent systematic review and meta-analysis[212]. During the weekend, elective patients numbered only a fraction of those admitted during the week – one-fifth to one-half – thus, decreasing the total number of patients admitted during the weekend when compared to the week. The exception is the specialty of anesthesiology, where admissions were similar in number every day of the week. This decline has been put forward as a reason for the weekend effect[155]. Both surgery and gynecology and obstetrics specialties had clear weekend effects for elective admissions in Studies I and II. Two common reasons for elective admissions during the weekend are sicker patients being admitted for preoperative monitoring for a procedure at the beginning of the week and the performing of procedures at the weekend to shorten waiting times. These weekend elective procedures are performed in addition to a standard 40-hour work week. Weekend on-call shifts are 24-28 hours long in general. Weekend effects in emergency patients were seen in the more labor-intensive on-call specialties: internal medicine, gynecology and obstetrics, and neurosurgery. The risk of accidents and serious medical errors increases cumulatively – after eight hours, it increases; after 12 hours, it doubles[213]. Sleep deprivation and long working days are known to increase this risk. Emergency admissions have previously been associated with a higher risk for mortality but as more resources are delegated to reducing waiting times in emergency departments, this risk may decrease[56].

6.1.4 CENTRALIZATION OF SERVICES

The centralization of healthcare services has been at the foreground of political controversy in Finland lately. The Act of the Centralization of Secondary and Tertiary Care (336/2011, 582/2017) dictates which services belong in secondary or tertiary hospitals and which are performed only in HUS[214,215]. On the one hand, centralization increases the experience of doctors at treating a certain diagnosis or performing a certain procedure through repetition. On the other hand, patients might have to journey long distances to reach the tertiary treatment center, which increases the risk of the golden hour phenomenon[216]. The longest distances inside the catchment area of Helsinki University Hospital are up to 200km. For the advanced specialized treatment only Helsinki provides, the journey from northernmost Lapland is up to 1,200km.

When examining the overall mortality by specialty and by year, we can see some possible effects of centralization. Thrombolysis of stroke patients was centralized to the university hospital in 2001. The highest risk of 30-day post-discharge mortality in emergency neurology patients also occurred in 2001, with the highest in-hospital mortality in 2002. In 2002, rare and difficult treatments were centralized to the university hospital. In 2003, low volume surgeries, oncologic surgery and pulmonary surgery, in addition to more difficult emergency cases, were also centralized. In both elective and emergency patients, 2003 was the second highest year for 30-day post-discharge mortality in surgery patients. For emergency surgery patients, 2002 was the second highest in-hospital mortality and third highest 30-day post-discharge mortality in this study in the university hospital. Nonetheless, all of these increases in risk decrease within a few years of the change. In April 2005, ST-elevation myocardial infarctions were centralized completely to the university hospital. There was no corresponding increase in mortality risk in 2005 in emergency internal medicine patients at the university hospital but there was, however, an increase in in-hospital mortality in secondary hospitals.

In the specialties of acute psychiatry, otorhinolaryngology, neurology and pediatrics there were no weekend effects in secondary hospitals. However, these weekend patients numbered a fraction of those admitted during the week, probably due to the more challenging cases being sent to the university hospital. More significant weekend effects were observed at the university hospital than at secondary hospitals among the non-centralized specialties despite lower mortality rates being used as pretext for centralization. While centralization does lower mortality rates for some patients (low-volume surgical procedures, oncologic surgery and trauma patients)[217–219], it does not hold true across-the-board[220]. Thus, the patients and diagnoses to benefit from centralization must be investigated.

The weekend effect cannot be eliminated by the centralization of services without first ensuring the unit on the receiving end of these patients is uniform in its expertise also during the weekend. Planning in order to guarantee that patient processes are resilient to staff rest periods is essential. Groundwork for treatment processes and ample skilled staff are necessary for the round-the-clock operation of health care.

The catchment area of HUS remained identical throughout the study period, which may be a rarity in organizations of this size. Consequently, the results of many weekend effect studies might not be transferable to healthcare organizations elsewhere. Notwithstanding, these studies can be used as invaluable clues to potential quagmires.

6.1.5 PREVENTABLE DEATHS

In Studies I and II, Wednesday was chosen for comparison in order to investigate the weekend effect. By calculating the crude mortality rates for Saturday and Sunday admissions and comparing them to the crude mortality rate of Wednesday, we can estimate the number of preventable deaths potentially attributable to the weekend effect. In Helsinki University Hospital, these deaths numbered 3,701 and in secondary hospitals 1,170, or 4,871 deaths in total. In these two studies, 64,353 deaths occurred altogether over 14 years. In other words, the preventable deaths comprised 7.6% of all deaths. This number is, naturally, only an estimation and only by reviewing all patient charts can we get an exact number.

6.2 FACTORS AFFECTING OUTCOMES AFTER DAY SURGERY

6.2.1 SEX

Female sex had an effect on the risk of an outcome in both Studies III and IV. Forty-six percent of ENT patients were women. The most common procedure was tonsillectomy (16.6%) and females numbered 57.7%. The most female dominant procedure was myringoplasty (73.3%). Of 34 overstays and readmissions, 19 were female. Sixty percent of OHS patients were women. Decompression of the median nerve was the most recurrent procedure (30.8%) and females numbered 74.3%. More than twice as many men (13.8%) underwent general anesthesia as women (6.2%). Of eight patients with overstays and readmissions, five were female. These female outcomes, nevertheless, were for more minor issues than those of men. One possible explanation for this increased risk may be that men, in general, use healthcare resources less than women[221–223].

6.2.2 FACTORS BEHIND OVERSTAY

Nausea and vomiting were the main reasons for overstay in this study for both ENT and OHS day surgery. Postoperative nausea and vomiting (PONV) are common after day surgery – 55% suffer from nausea and up to 16% vomit[224]. Trigeminal nerve stimulation, diathermy use, gastrointestinal irritation from swallowed blood, opioid use and tracheal intubation have been shown to increase the risk of PONV, with female sex actually tripling the risk[225,226]. Tonsil and adenoid surgery is also a common risk factor for PONV, especially in children, who have a PONV rate of 54% in some studies[227,228]. Research has shown ondansetron to be effective after both ENT and OHS surgery[229–231] and gastric compression after ENT surgery in the prevention of PONV[232].

In Study III, eight ENT overstays were due to PONV. Of these eight, five (3 adult females, 2 male children) involved tonsil or adenoid surgery. In Study IV, two overstays were due to PONV and both occurred in male patients. However, a large amount of oxycodone and fentanyl, use of remifentanil and general anesthesia were involved in both cases.

At the Helsinki University ENT Clinic, ondansetron is given routinely as first-line prophylaxis for postoperative nausea and vomiting, with droperidol (or dehydrobenzperidol, DHBP) given in addition if needed to combat the nauseainducing effects of opioids. Metoclopramide is sometimes used as a treatment for nausea and vomiting but only in adults at the clinic, due to its tendency to cause extrapyramidal symptoms in children. At the Helsinki University Orthopedic and Hand Day Surgery Unit, antiemetics are not given prophylactically but rather as needed, with ondansetron as first-line treatment and DHBP as second-line treatment. Gastric decompression is done as needed but is not routine at either clinic. The use of nitrous oxide is also not routine due to its tendency to cause nausea and vomiting.

6.2.3 FACTORS BEHIND READMISSION AND CONTACTS

Operation site bleeding after tonsil and adenoid surgery was the main reason for readmissions and contacts in ENT day surgery patients. Previous research has shown a contact rate of 11.6%[233] and a hemorrhage rate of 15% after tonsillectomies[234]. In a previous study at our ENT clinic, the hemorrhage rate was 14.5% in the adult population[235]. A hemorrhage rate of 2.3% after tonsillotomies was found previously[234]. These numbers are similar to later studies[236,237]. Hemorrhage rates of 0.05-0.5% after adenoidectomies have been found[238,239]. These hemorrhage rates are all in line with Study III of this thesis.

In England, nasal day surgery readmission and overstay rates were 2.88% and 9.62% respectively, with the most common reasons being nasal bleed (28.9%) and postoperative pain (23.7%)[173], while in the US, the 14-day revisit rate was 5.0% and 14-day mortality rate of 0.0084%[173,240]. We found a sinonasal day surgery overstay rate of 1.54% and a readmission rate of 0.39%. This variation in rates between previous studies and the rates of HUS could be due to the smaller nasal surgery cohort in this study (312 in Singh's study and 35,678 in Bhattacharyya's study vs 256 in this study). In addition, Bhattacharyya's study examined the revisit rate, which included both readmissions and visits to the emergency room. The English study was comprised of patients operated on in 2002-2003 and the American study in 2010, while the patients in this study were operated on in 2015. Developments in operation technique and equipment during this time period from 2002 to 2015 may have facilitated a less traumatic surgical result and therefore, less bleeding and pain, and in turn a lower readmission and overstay rate in this study.

In Study IV, readmissions and contacts were mainly due to operation site infection and mostly involved the hand surgery procedure group. An infection rate of 1.1% postoperatively occurred in Study IV, which is in line with previous infection rates in hand surgery of 0.36% to 3.8%, peaking as high as 10.7% in one report[184,241–243]. Two of these patients received prophylactic antibiotics in conjunction with surgery – one cefuroxime, one clindamycin. The patient with two readmissions due to infection had moderate recurrent depressive disorder and a variety of antidepressants, pain medications and sedatives in use. These factors could have factored into their risk for infection. For the total six revisits of two patients, the patients had no underlying medical condition or factors to increase their risk of infection. One of these patients, who had 2 revisits, also required revision surgery. For two patients with one revisit each, smoking was a factor for infection. One patient with three revisits was a diabetic. A total fentanyl dose of more than 150ug was found to be a significant factor for readmission and other study outcomes. This is in line with a previous study on all specialties of ambulatory surgery and readmission[244].

In the US, readmission rates for orthopedic day surgery have been reported as 1.2-2.5%[174,176]. The readmission rate in this study of 1.1% is lower than these rates and also below the guidelines of the Royal College of Surgeons[8].

6.2.4 LOCAL ANESTHESIA

The suitability of local anesthesia for septoplasty patients has already been investigated in HUS. Hytönen et al. found that only 3.6% of all septoplasty and septocolumelloplasty patients were not satisfied with pain prevention and treatment, with 90% of patients undergoing local anesthesia[245]. Seven postoperative infections (4.2%) occurred in Hytönen's study. During our study period, 77.8% (n=28) of septoplasty and 78.6% (n=11) of septocolumelloplasty patients received local anesthesia, with one overstay for hemorrhage and six contacts for varying reasons (infection, swelling, stuffiness and at the patient's request) for septoplasty patients and no overstays, contacts or readmissions for septocolumelloplasty patients. Two infections occurred in septoplasty patients, with both patients having received antibiotic prophylaxis (cefuroxime 1.5g i.v.) before the start of the operation. One patient was operated on by a rhinologist, while the other by a resident. In the aforementioned study at our clinic, there was a higher infection risk in septoplasties performed by a resident, which was thought to be due to a more traumatic technique and also longer operating time associated with residents. Rhinologists usually operate on the most difficult cases and also maxillary surgery was done on the patient in question at the same time. Both are possible factors affecting the risk of infection. No readmissions, contacts or overstays were due to pain management issues. This once again shows that septal surgery can be performed under local anesthesia. Study III showed that form of anesthesia did not affect study outcomes in ENT day surgery. Therefore, local anesthesia should be championed when medically feasible. While some procedures, like tonsil surgery, can in practice be performed under local anesthesia, few patients are willing to agree to this due to discomfort, fear of seeing blood and the unpleasantness of continual gagging. Consequently, general anesthesia cannot be done away with entirely.

6.2.5 EXCEPTIONS TO DAY SURGERY CRITERIA

The day surgery selection criteria used in the hospital district comply with international guidelines[246] and are as follows: operation duration of less than 3 hours, no significant risk of respiratory tract swelling, no respiratory tract anomalies, no or stable chronic disease, no obstructive sleep apnea, body mass index of less than 35 kg/m^2, ability to climb more than 2 flights of stairs without stopping, ability to care for oneself independently, no unstable psychiatric illnesses, no drug or alcohol addiction and a caregiver over the age of 16 at home for the first postoperative night.

In Study IV, contrary to the day surgery eligibility criteria of no obstructive sleep apnea and BMI<35, 20 patients had sleep apnea and 52 had a BMI>35. No study outcomes involved these 20 sleep apnea patients. Only three severely obese patients had study outcomes. These outcomes involved large amounts of opioids, diabetes and trauma to the operation site from a fall. Of these 52 severely obese patients, only two were operated on under general anesthesia and one of these two had an outcome. The BMI criteria for day surgery may be unnecessarily stringent and need readdressing.

6.2.6 PROBLEMATIC PROCEDURES

In Study III, there was a disproportionate number of young adults and females with study outcomes after having undergone myringoplasties (DCD00), stapedotomies (DDA00), maxillary antrostomies (DMB20) and tonsillectomies (EMB10). Both myringoplasty patients with an overstay or readmission were young female adults aged 16-44 years. All stapedotomy and tonsillectomy patients with overstays and readmissions were young adults (ages 16-44 years). Of these tonsillectomy patients, the majority was also female. Of the contacts regarding these four operations, the majority involved young adults (ages 16-44 years), as well as all or the majority involving females. Of the 184 16 to 44-year-old females undergoing day surgery, ten (5.4%) had an overstay or readmission and 42 (22.8%) had a contact. These patients were clearly more sensitive to study outcomes and this overstay and readmission rate is greater than the one put forth by the Royal College of Surgeons[8]. Their suitability for day surgery should be discussed with the individual patient and their wishes for anesthesia and possible inpatient care should be considered carefully. The less severe outcomes of females may be connected to the tendency of females to utilize health care in general more than males[221–223].

In Study IV, removal of internal fixation device from shoulder (NBU20) and partial fusion of wrist (NDG20) are notably more painful than the other procedures in the study. These patients need more pain management perioperatively and at home, and most of these patients underwent general anesthesia. The majority of overstays and readmissions involved these two procedures. Six NDG20 patients had outcomes: five underwent general anesthesia and one plexus block. An infusion of remifentanil and repeated doses of fentanyl are administered during general anesthesia when a procedure is known to be painful. Opponents may contend that these procedures are not suitable for day surgery but provided that a possible problematic recuperation is acknowledged by both staff and patient, day surgery is still a possibility.

6.2.7 RISK PROFILES

In Study IV, two risk profiles had an approximately 15-fold risk for a study outcome. Both involved females who had been administered a large amount of fentanyl. One profile also involved administration of remifentanil and the other plexus block. These two profiles identified half of patients with a study outcome. The sex of the patients and possible use of remifentanil and plexus block are usually known when scheduling patients for surgery. Nevertheless, the total need for fentanyl only transpires perioperatively. Contingency plans for high-risk patients who require fentanyl should be set into place and whether these patients are appropriate for day surgery should be evaluated. The previous anesthesia records of these patients could be reviewed before surgery, and if they required fentanyl in large amounts, inpatient surgery scheduled.

6.3 STRENGTHS AND LIMITATIONS

6.3.1 WEEKEND EFFECT (STUDIES I AND II)

Studies I and II are the broadest on the weekend effect published so far in the Nordic countries, bringing a specialty-specific perspective to the weekend effect debate. Specialized health care is mainly provided by the public sector in Finland. Consequently, residents of Finland receive necessary health care regardless of their ability to pay. At the time of this study no private on-call hospitals existed and thus, possible skewing of the data through the caring for healthier, younger, financially sound patients in private hospitals is prevented. Due to these factors, our data is a comprehensive representation of in-hospital specialized treatment in the greater Helsinki area from 2000 to 2013. Due to a homogenous population, with only 7% of Finland's inhabitants of foreign ancestry[247], the genetic variability of the patient cohort concerning mortality is somewhat diminished.

There were some limitations. Administrative data are known to be troublesome due to missing data and clinical coding errors. Firstly, this manifested itself in Study II in the inability to analyze mortality compounding comorbidities like diabetes, hypertension or heart failure. Doctors of different specialties chart comorbidity diagnoses with differing success. Moreover, accurate coding does not express disease severity or whether treatment for the disease is in balance. To combat this problem, we used the risk category technique to factor in disease severity. Weekend effect has been confirmed to exist, even after correction for comorbidities[159]. Secondly, unreliable time stamps prevented the analysis of off-hour admissions on weeknights. Some specialties had an end-of-the-week effect, which may be due to admissions on Friday evenings after 3:30pm or early Monday mornings before 8:00am when reduced weekend staffing is still in effect. That being so, these patients could alter the weekend effect. Thus, only cautious conclusions concerning the root causes behind observations on the weekend effect can be made based solely on administrative data.

Socioeconomic factors were not included as variables in the analyses of this research. Factors, such as race, ethnicity, education level and income, are not documented in the administrative data of Finnish hospitals. Zip code or address cannot necessarily be used to deduce this information either. Only 1.8% of the country's inhabitants were of foreign descent (0.5% of non-Caucasian descent) in 2000, when Studies I and II began, and only 3.8% (1.1% non-Caucasian) in 2013 at the end of Studies I and II[248]. This makes for a quite homogenous study population. Public housing is spread throughout the city in order to avoid forming underprivileged areas. Universal health care and free education, in addition to progressive income tax, ensure the socioeconomic equality of inhabitants and help counteract extreme wealth and poverty. However, there may still have been differences in mortality between socioeconomic classes even if these socioeconomic factors had been taken into account.

Hospital mortality as a measure of quality is troublesome. Mortality is inevitable but preventable mortality due to poor care is avoidable. On the one hand, death is a concrete, black-and-white concept. On the other hand, as with the measure of readmission, one must precisely define what is included in these measures. For example, do we include palliative patients? Is it really a failure in quality if a palliative patient dies due to the natural course of disease? The study by Pearse et al[44] (mentioned in 2.4.1. Mortality) is a prime example of comparing apples to oranges. When investigating mortality, precision and accuracy, as well as sound inferences, are crucial. One cannot extrapolate the mortality over one week in six hospitals to represent the surgical mortality rate for the whole of Poland as was done in Pearse's study. This leads one to question the accuracy of the statistics in Pearse's study pertaining to Finland as well.

Hospital mortality as a patient safety indicator speaks to possible organization-wide problems but does not allow for analysis on an individual level. The level of information acquired is very generalized and adjusting for certain varying factors between patients can be problematic. As with big data in general, the information used was originally stored for administrative purposes, not research purposes, and can be lacking crucial variables, like disease severity. In addition, HUS is the largest hospital district in Finland with a prominently urban population. These results may not necessarily be generalized directly for more rural areas. Furthermore, mortality and readmission are indicators for secondary and tertiary care levels and do not tell us anything about primary care. Therefore, extrapolation of results to other healthcare facilities is complex. However, by using hospital mortality as a starting point, we can find the patient groups more prone to issues and work onwards to finding the deeper pitfalls in patient care.

6.3.2 DAY SURGERY (STUDIES III AND IV)

While both articles propagated the idea of increasing day procedures performed under local or regional anesthesia, this research did not examine how patients tolerated the procedures or whether they were satisfied and willing to undergo local anesthesia again if the opportunity arose. The clear majority of septoplasty patients in our clinic were satisfied with local anesthesia[245]. The experience and expression of pain are individually, culturally and generationally rooted. Due to these reasons, our observations may not be able to be extrapolated to other countries. Older patients (aged 65 years and older) performed well, which may be attributable to the aforementioned circumstances. Due to the nature of certain procedures, like tonsil and shoulder surgery, the complete phasing out of general anesthesia is not achievable. Management of patient concerns and proper postoperative guidance is crucial.

In both studies, access was only available to patient records of the hospital district and its emergency departments. Therefore, patients presenting to other hospitals, their own general practitioner or to the private sector are not included. These patients, however, are most likely few and far between as patients are instructed to contact the day surgery unit or emergency department directly and are usually referred to the emergency department if presenting elsewhere. These facilities often do not have the means to treat all postoperative problems, e.g. hemorrhages. In addition, both studies were carried out retrospectively by reviewing patient charts. All calls may not have been charted if just general advice was given or due to absent-mindedness. No contact was made to the patients in these studies to verify the course of their postoperative recuperation or their satisfaction with treatment. In addition, three anesthesia charts of OHS patients were missing from the hospital archive. Nevertheless, most necessary information was available through electronic patient charts and only intraoperative information was absent. The OHS surgery groups were skewed in size due to most patients belonging to the hand surgery group.

Readmission as a measure of patient safety and quality of care is also as problematic as hospital mortality. Definitions of what constitutes a readmission vary from organization to organization. In these studies, every single contact mentioned in the electronic charts was included but often e.g. phone calls are omitted. Problems with upcoding and keeping patients under observation instead of admitting them are well known and have been mentioned widely in studies in the US and United Kingdom. Pressure, in regard to these activities, does not yet exist on the clinician level in Finland. Hopefully, too much stock will not be placed in just a few measures. Otherwise, we run the risk of having the same problems here. Examining the reasons behind readmissions is important to find preventable problems but total elimination of readmissions is not feasible. Unfortunately, readmissions, as with hospital mortality, are an inevitable part of the natural progression of disease. For example, if certain surgical patients have an infection problem, one can investigate where the issue lies (a certain member of staff, operating room etc.) and target resources on improving that issue. However, infection is a known complication of surgery and complete elimination of postoperative infections is an unrealistic task. Of course, this should not hinder us from striving to eliminate all preventable infections. Post-discharge care, clear treatment and follow-up plans, as well as access to general practice level services, are invaluable. By guaranteeing their fluidity, we can reduce the number of bouncebacks to the emergency room.

6.4 PRACTICAL IMPLICATIONS

6.4.1 WEEKEND EFFECT CAN BE DIMINISHED

Organizational changes and other upheavals of daily routines (e.g. doctors' strike and the following backlog of surgeries, centralization of rare and difficult treatments etc.) were reflected in weekend effect rates. In the future, it is essential to increase staffing to ensure a smooth transition during these planned times of change. At the time of writing this, the introduction of a new electronic patient chart system (Apotti) in the hospital district is underway. Plans to ensure staffing, training and backup plans have been prepared. It will be interesting to see how this will affect mortality and readmissions.

For the specialties of internal medicine, neurology, gynecology and obstetrics, and surgery, disease-specific weekend effects need to be evaluated in order to find the patients most benefitting from increased and more senior staffing. It would not be feasible to staff every emergency department with only specialists and run a seven-day-a-week service. These changes would require a change in the number of doctors produced by medical schools and also would require a long implementation phase. More prospective research is requisite due to the constraints of retrospective research utilizing administrative data. A trial period with increased specialist staffing could also be put in to practice in order to see what effect it would have on the weekend effect. It is also necessary to examine the effect the emergency medicine specialty has had on the weekend effect.

As there was a clear weekend effect among some elective patients, guidelines for elective weekend admissions need to be drawn up in order to fine-tune patient selection. These guidelines could be akin to day surgery criteria.

6.4.2 DAY SURGERY

Now that some factors affecting outcomes are known, validation by prospective studies on patient selection is needed. Studies comparing problematic procedures under local versus general anesthesia are necessary. If a clear pattern in complications is observed, changes to day surgery criteria should be made and patient anesthesia and treatment tailored to the best specifications for each individual patient. A prospective randomized control trial could be planned in order to test the patient profiles found in this research.

At this time, the hospital district is undergoing steps to achieve Joint Commission International (JCI) accreditation. The effects of this project could be mirrored on the patient safety and quality of care of the hospital district, forming a compelling subject for study from the perspective of the weekend effect and readmissions.

6.4.3 PATIENT SAFETY CULTURE

In general, the attitude towards the subject of patient safety and quality in healthcare on the grassroots level of health care is rather lackluster. The most common complaints are of too much bureaucracy, difficult reporting systems and the lack of actual changes. Reporting safety incidents needs to be made easier as to create a lower threshold for the individual to take action. Once a safety incident report has been made the individual also needs to feel like there was a point to the report and that the problem will be investigated, and action taken. Ineffectual action causes the individual to feel like they wasted their time and the endeavor was pointless. Faceless communication and directives from higher up the chain of command do little to inspire staff and even well-intentioned innovations go amiss due to bad implementation and staff cynicism. Patient safety culture needs to be spread from above. If staff see that patient safety is not taken seriously by senior persons in the organization, they probably will not take it seriously themselves. Smaller projects honed and tested in one unit or clinic, and then brought out on an organizational level, are key to capturing staff interest, maintaining motivation and reducing frustration and disinterest over new projects. Fun and innovative use of social media and other current vehicles for promoting safety and quality are a must for bringing the dated hierarchy of medicine into the 21st century and engaging younger generations of staff. Change resistance from older generations is also a problem, which needs to be addressed by e.g. slow enough rollouts of changes.

6.5 ETHICAL IMPLICATIONS

As with all research, we must ponder the ethical dilemma involved in this study. General codes of conduct have been established in biomedical research, e.g. the Nuremberg Code and the Declaration of Helsinki, and this study has strictly adhered to these codes. This study has also adhered to the four basic ethical principles of research: respect for persons (autonomy), beneficence (maximum benefits, minimum harm), non-maleficence ("Do no harm") and justice[249]. This study is deemed as being of minimal risk according to WHO Guidance Point 3 for ethical issues in patient safety research[250]. This research was registry-based and no patient interventions were involved. In other words, patients gave no consent to participate in this study, as with all purely registry-based studies. On the other hand, one could argue patients were also under no direct harm. The gravest harm in a registry study is the failure of data protection and the falling of sensitive information into the wrong hands. In all four component articles, data was anonymized and handled in accordance with the Medical Research Act of Finland (488/1999) and the EU Data Protection Act (2016/679). This data was stored electronically with data protection tools and limited access.

Another ethical quagmire in registry studies is the needs of a few versus the needs of the many. In other words, is the possible gain achievable on a public health level greater than the possible risk to the rights of the individuals involved? In patient safety research, often the subject of the research is indirectly the healthcare provider. When we improve documentation of failures in treatment, we can inadvertently harm the institution. When publishing on patient safety problems at a certain healthcare institution, we may unjustifiably damage the reputation of the institution and undermine patients' trust in this provider. If researchers are employed by the institution under investigation, one must be critical of results. Researchers may feel pressure not to tarnish their own employer. If a researcher finds an error in treatment that occurred in the past, what is their duty to report it? According to WHO Guidance Point 10, it is the researchers duty to intervene if they suspect an "incident has occurred; intervening could reverse some of the negative medical effects of the incident; no intervention has already occurred and the consequences are of direct, severe or irreversible harm"[250]. Nonetheless, one could also interpret this to mean that if all four points are not present, then intervention is not necessary.

Patient safety research necessitates a "no blame" culture. Otherwise, those involved may suffer undue psychological stress if they are in fear of a witch hunt. This is yet another reason that speaks for the anonymization of data at the earliest possible point. Registry studies under the guise of quality improvement do not require Research Ethics Committee review[250]. However, the line between quality improvement and research is fickle. The WHO recommends Research Ethics Committee review for any patient safety activity that constitutes research when "they are aimed at addressing a specific question; and they use a predefined approach or method for collecting data in response to the question they intend to address;…"[250]. Nevertheless, Finnish legislation (The Medical Research Act of Finland 488/1999) does not require Research Ethics Committee approval for registry studies without patient intervention[190]. This ethical predicament could be circumvented by posting announcements in hospitals or including a pamphlet with other patient materials informing patients that patient safety research is routinely performed for quality control purposes and what exactly this entails.

Research is obliged to be beneficial to society, as well as affect and change the world in some way. Credit must also be given to all those involved and all results, favorable and unfavorable, published[251]. All these criteria were fulfilled in this research.

7 CONCLUSIONS

Patient safety in HUS seems to be of a high standard but there is some room for improvement in regard to the weekend effect and day surgery.

1. The specialties most sensitive to the weekend effect were surgery, neurology, internal medicine, and gynecology and obstetrics. These specialties, in addition to diurnal changes in mortality, should be investigated more thoroughly in order to find the specific diseases that would best reap the rewards of increased senior staffing and targeted funding allotment.

2. Due to the clear weekend effect in elective admissions, patient selection for weekend admission must be scrutinized. While total cessation of elective procedures at the weekend cannot come into question owing to lengthy waiting lists, guidelines should be drawn up to help reduce hospital mortality.

3. The day surgery criteria of HUS are stringent enough. Some criteria could be relaxed, e.g. BMI.

4. The overstay, readmission and contact rates in both ENT and OHS day surgery are on the same level, or even lower, than in previous studies elsewhere.

5. Local or regional anesthesia should be favored whenever medically and procedurally possible.

6. For patients belonging to a risk profile, history of previous procedures should be examined, and new day surgery procedures planned accordingly, in regard to pain medication and day surgery eligibility.

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